Human Computer Interaction CS449 – CS549

Week-5
Psychology of HCI - 1

KÜRŞAT ÇAĞILTAY

Assignment-2 - Fitts' Law

- Find design problem(s) that can be measured by Fitts' Law and propose a solution – Due October 23rd Wednesday
- Report:
  1. Problem Definition –How is the design problem related with Fitts' law?
  2. Calculate the Difficulty Index (DI) of the design problem.
  3. How to eliminate the problem from the application. Use Figma prototyping tool, revise the design, calculate new DI
  4. References

Understanding the user (part 1) Human Cognition

Week-5 The Human, Ch1 - Human Computer Interaction, Dix et.al

Week-5 (Focus on Section 2.1) The Psychology of Human Computer Interaction - Ch2

Four Principle components of an HCI System

Tool

In Context

User

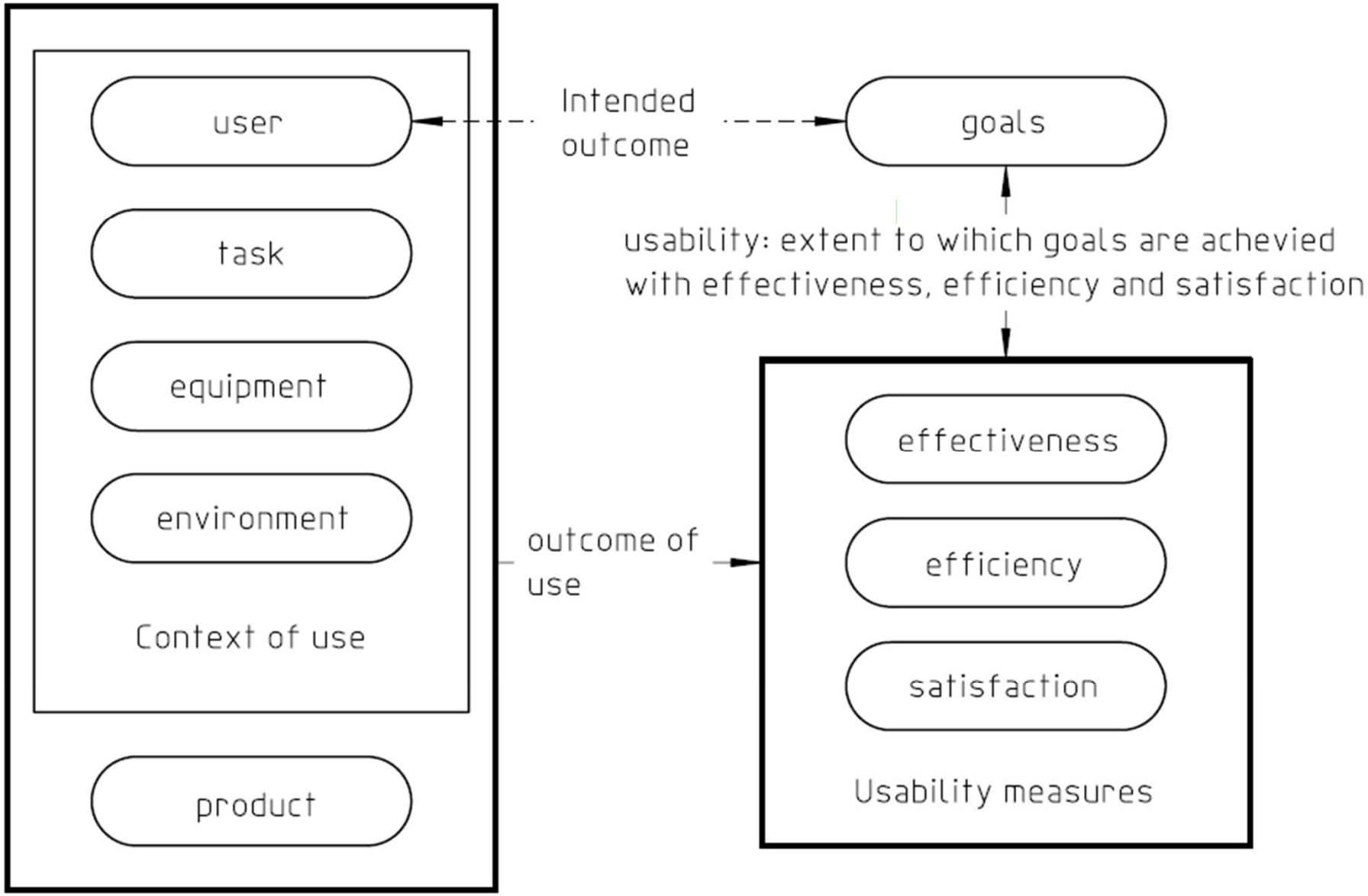
Task/Goal

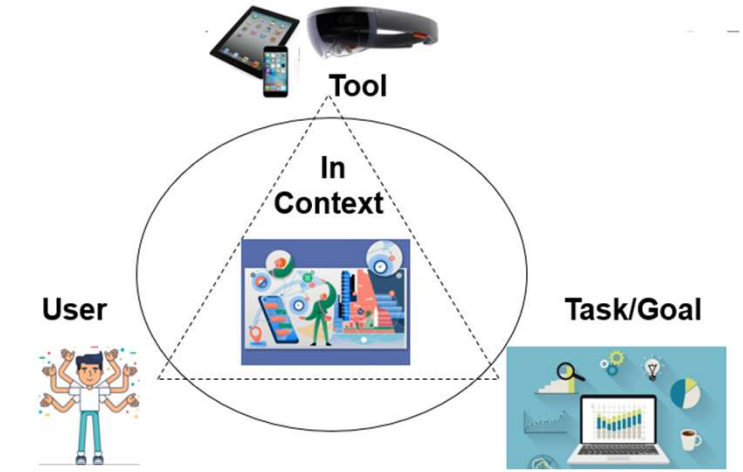
Operational definition - Universal

- Usability (of an application) refers to the effectiveness, efficiency, and satisfaction with which specified users can achieve specified goals in particular environments

ISO Ergonomics requirements, ISO 9241 part 11: Guidance on usability specification and measures.

Usability Framework (ISO 9241-11)





Effectiveness

the accuracy and completeness with which specified users can achieve specified goals in particular environments

USABILITY

Efficiency

the resources expended in relation to the accuracy and completeness of goals achieved

Satisfaction

the comfort and acceptability of the work system to its users and other people affected by its use

ISO 9241:2018

Effectiveness (etkililik)

- The extent to which users can achieve their task goals.
- Effectiveness measures the degree of accuracy and/or completion

e.g., if desired task goal is to locate information/action on a web site then:
Effectiveness= success of user in locating the correct data/action

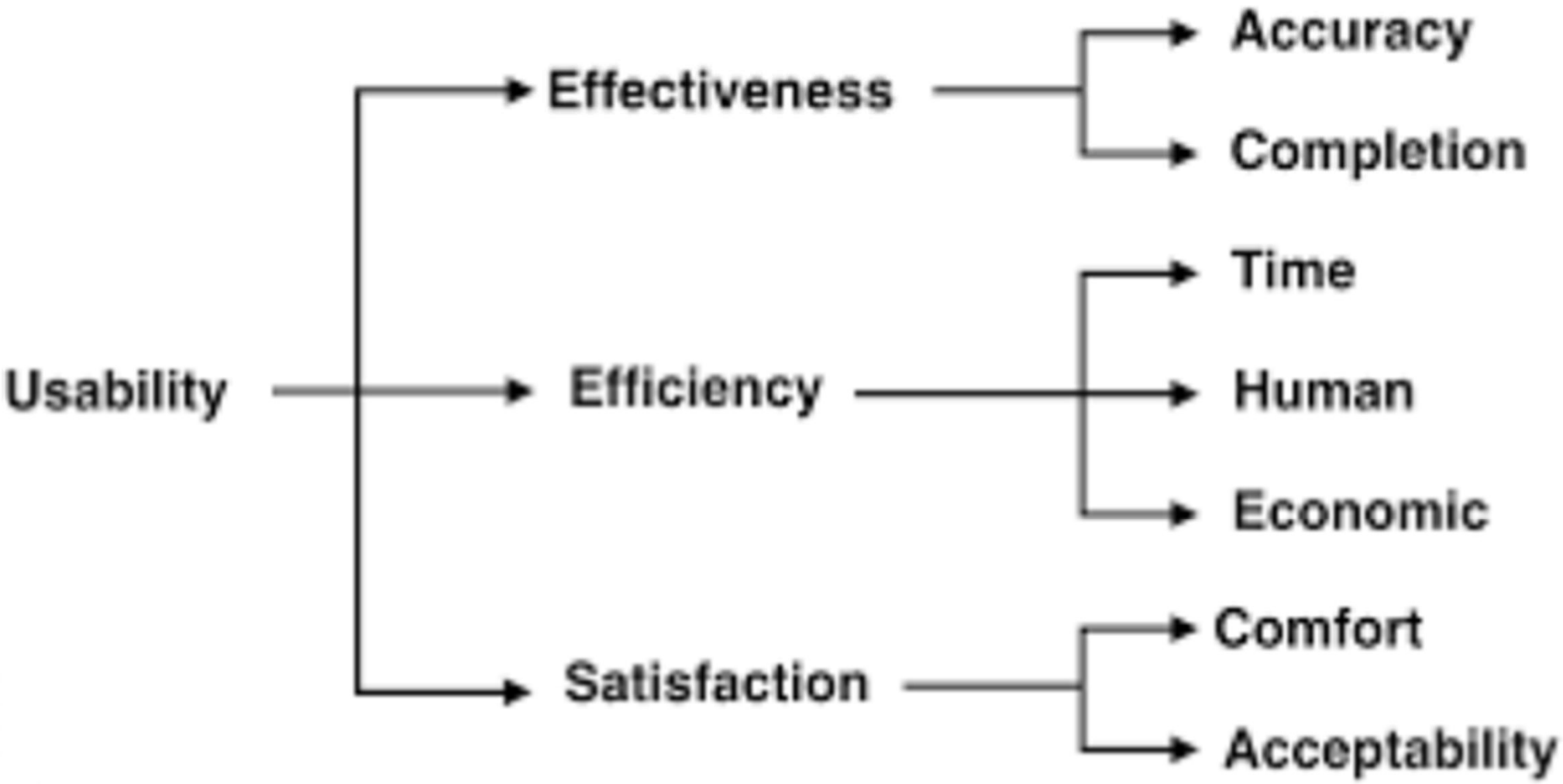
Efficiency (verimlilik)

- Measures resources used to perform task
  - i.e., time, effort, cost,

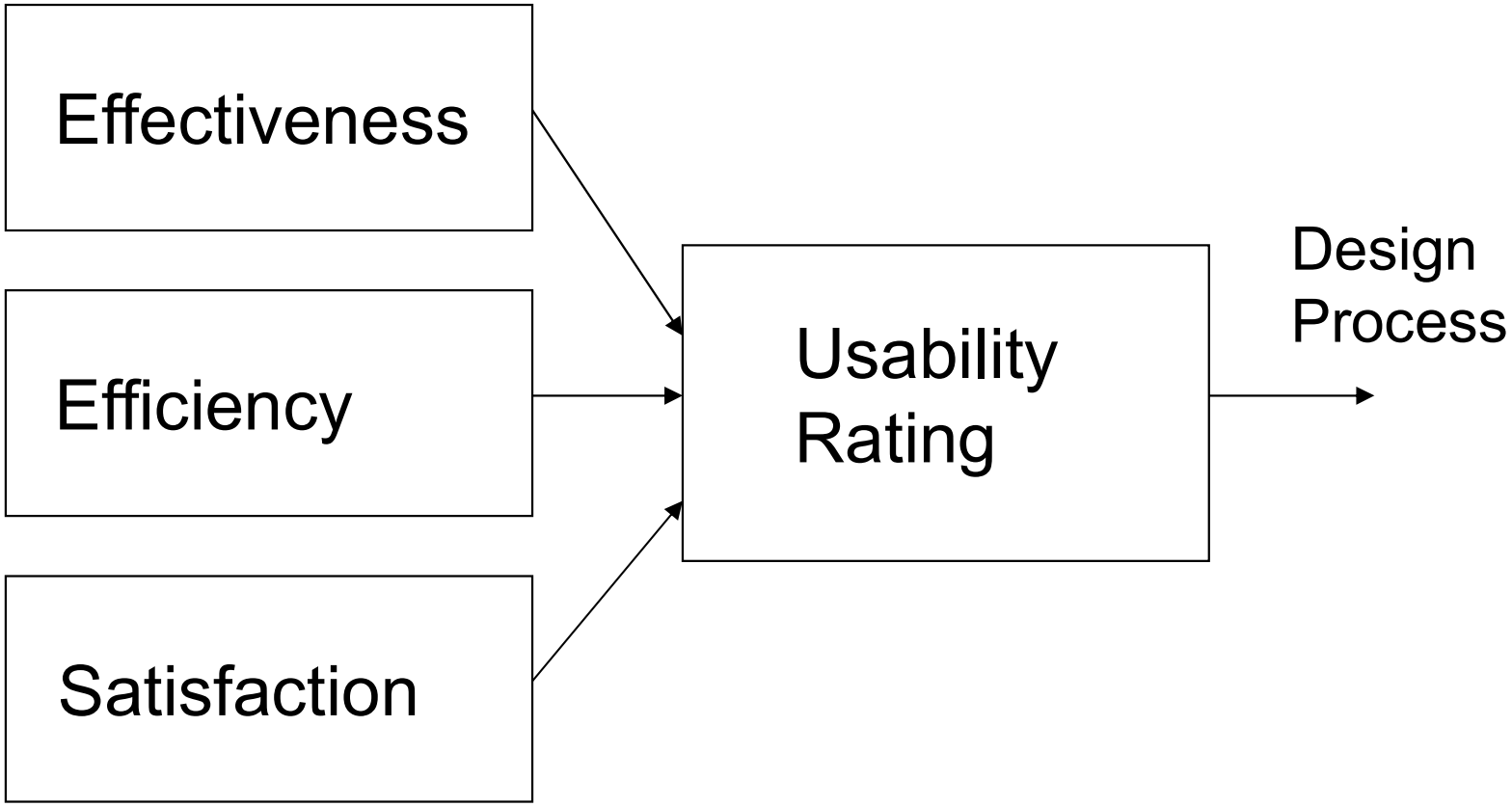
- In case of Web site use, efficiency might equal time taken to complete a task or the navigation path followed etc.

Satisfaction (Affect)

- Measures the affective reaction (likes, dislikes, attitudinal response) of users to the application
- Assumed to be influenced but not the same as effectiveness or efficiency e.g.,
  - 2 applications with equal effectiveness, and efficiency, may not be equally satisfying to use
  - or What users like might not be what they need!

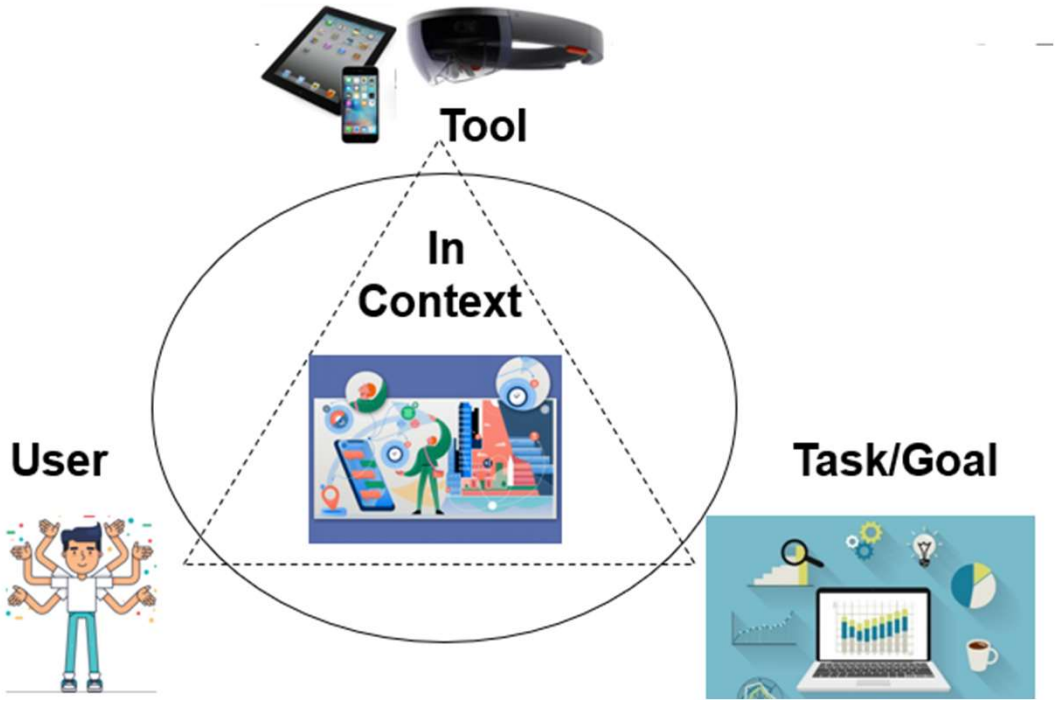

Usability
Effectiveness
Efficiency
Satisfaction
Accuracy
Completion
Time
Human
Economic
Comfort
Acceptability

Determinants of usability rating



How are criteria derived?

- User analysis
- Task analysis
- Situation/context analysis



User analysis

- Determine key variables:
  - work and task skills
  - computing experience
  - training
  - support
  - working practices
  - and many other variables
- Personas...
- In your usability assignment-6/termproject, you must add persona(s)....

Task analysis

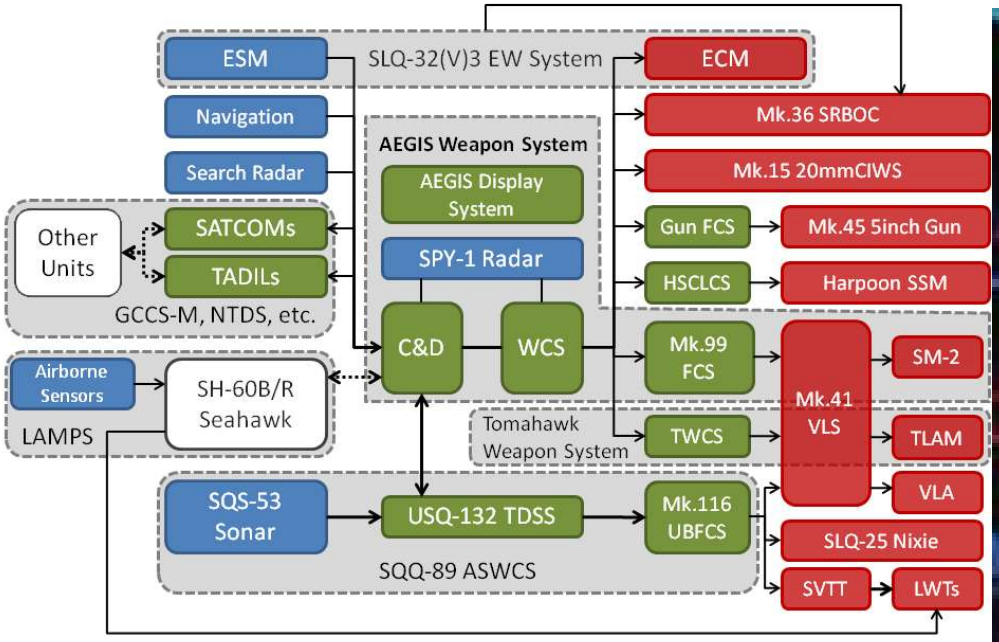
- The process of observing, describing, and decomposing tasks into their constituent components
- analyzing the human, technological and environmental resources required for the completion of each component.

Situation-Context analysis

- Outlines the physical and social context of use:
  - Location
    - Home, office, shop, car, street etc.
  - Relationship to other users
    - Collaboration, recipient, passive/active
  - Socio-technical environment
    - Sabancı: different departments/faculties

- Context related disaster!

Deadly Interaction Design

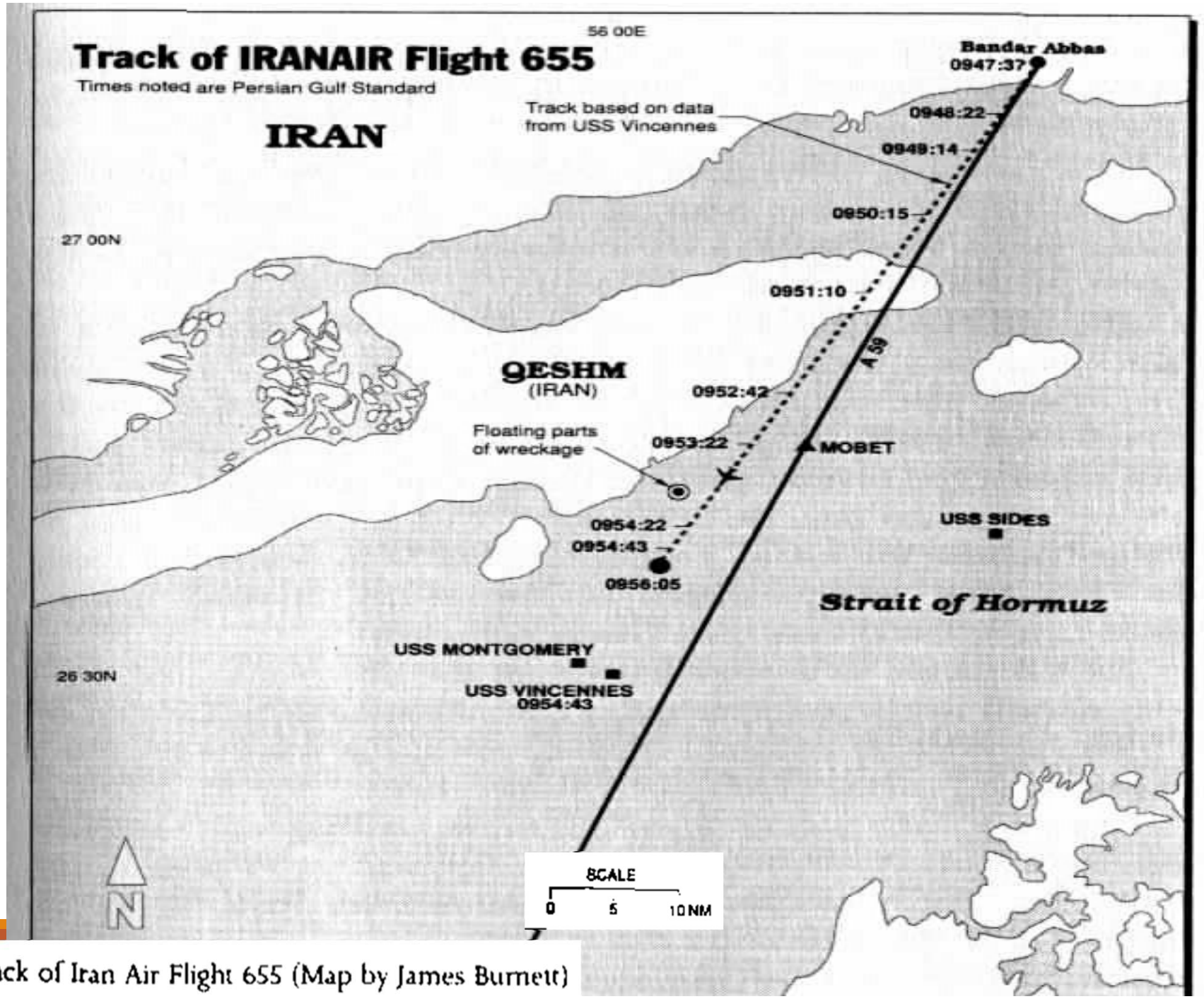


Deadly Interaction Design :

- USS Vincennes in Persian gulf (1988)
  - Receives ambiguous information regarding approaching aircraft
  - Crew found it difficult to ascertain whether plane was ascending or descending
  - Quick decision had to be made
  - Iranian passenger airline shot down, 290 dead

- https://youtu.be/DPHGUQrixWc?feature=shared&t=2193
- https://youtu.be/M14H14ckWj8

https://en.wikipedia.org/wiki/Aegis_Combat_System#System_problems



Track of Iran Air Flight 655 (Map by James Burnett)

Deadly Design problem:

- In ships control room, three huge screens showing all the planes in the air—but they don't show a flight's speed, range and altitude.
- An operator must summon that information manually, and it appears on a tiny 12-inch screen
- This lead to faulty identification

«ineffective user interface design caused poor integration with the crisis management human processes» (AEGIS Combat system)

Lessons Learned

- NATO STANAG 4586 standard was developed after this event


SCIENTIFIC AMERICAN

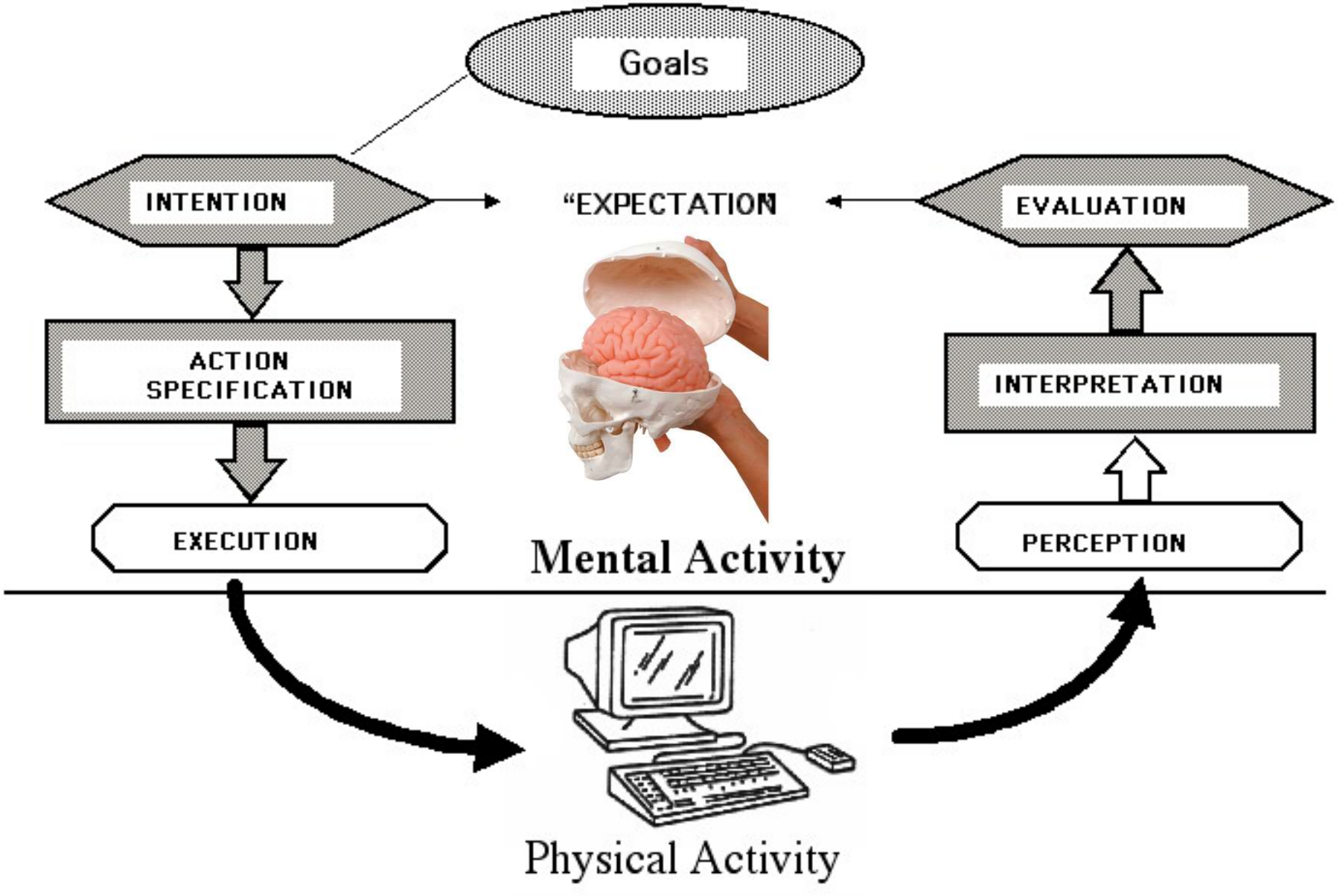
Sul

TECHNOLOGY

5 of the Worst User-Interface Disasters

Why your intelligence has nothing to do with using technology

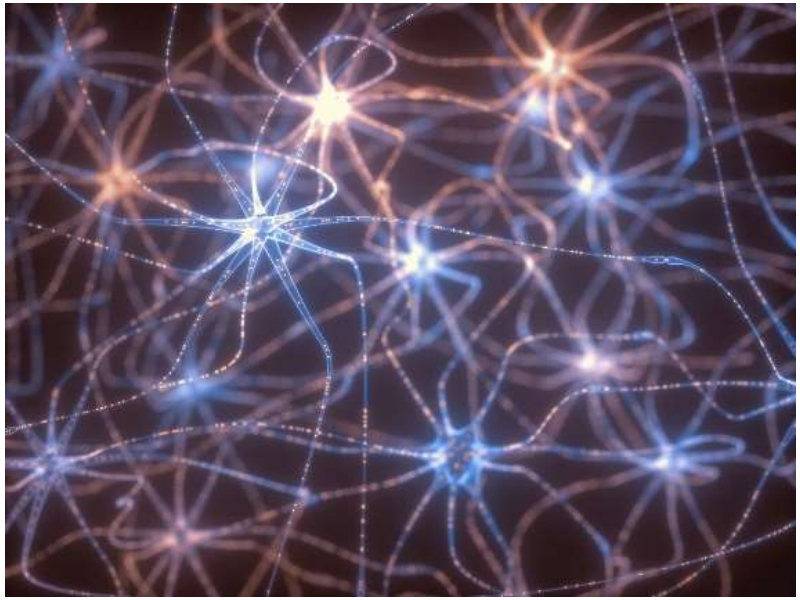
By David Pogue on April 1, 2016

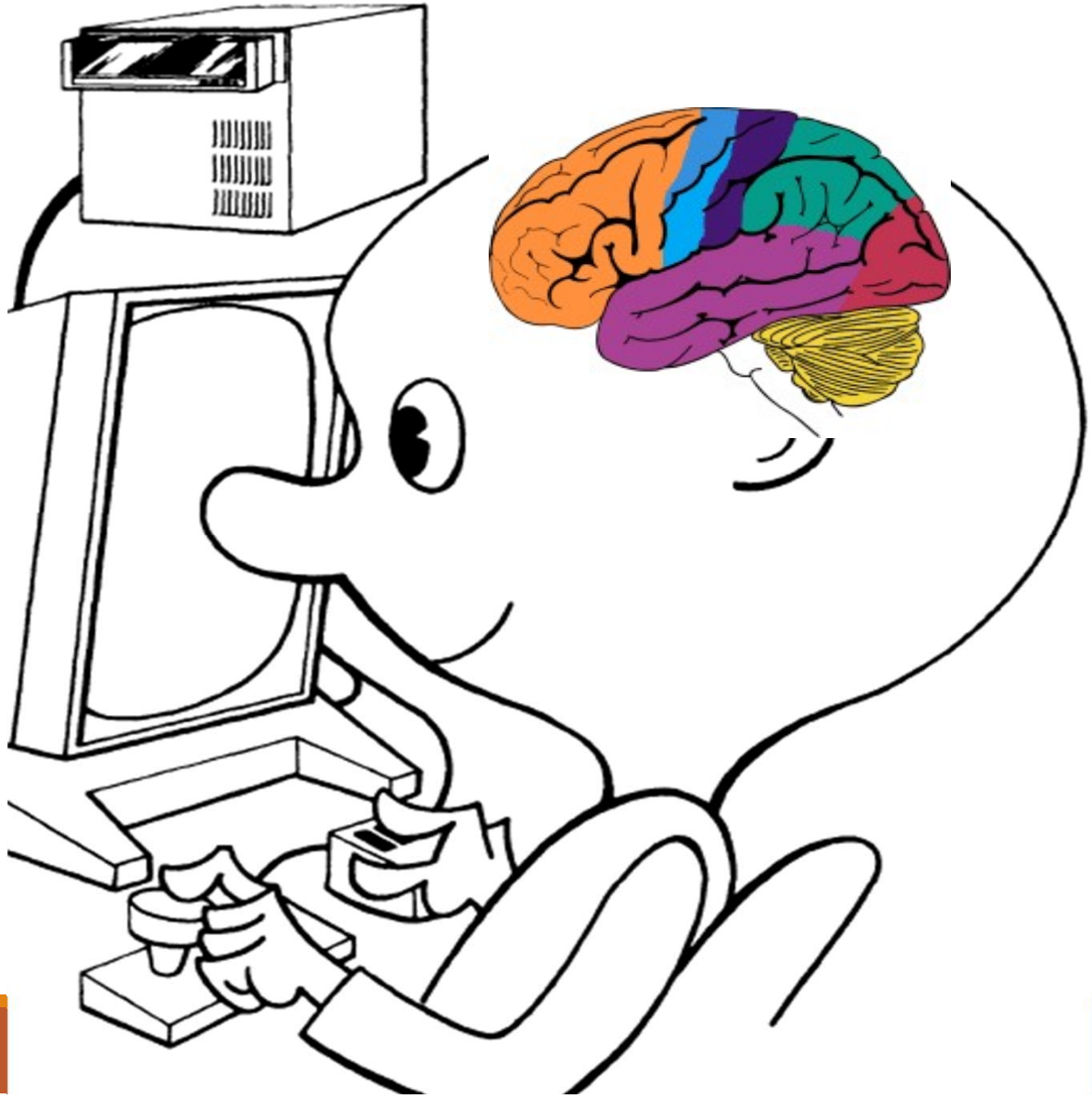


Seven stages of user activities involved in task performance

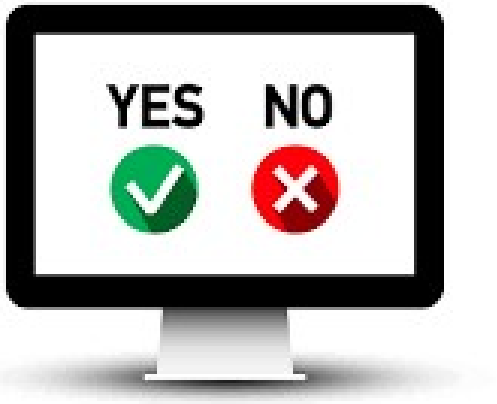
Don Norman ***The Design of Everyday Things.***

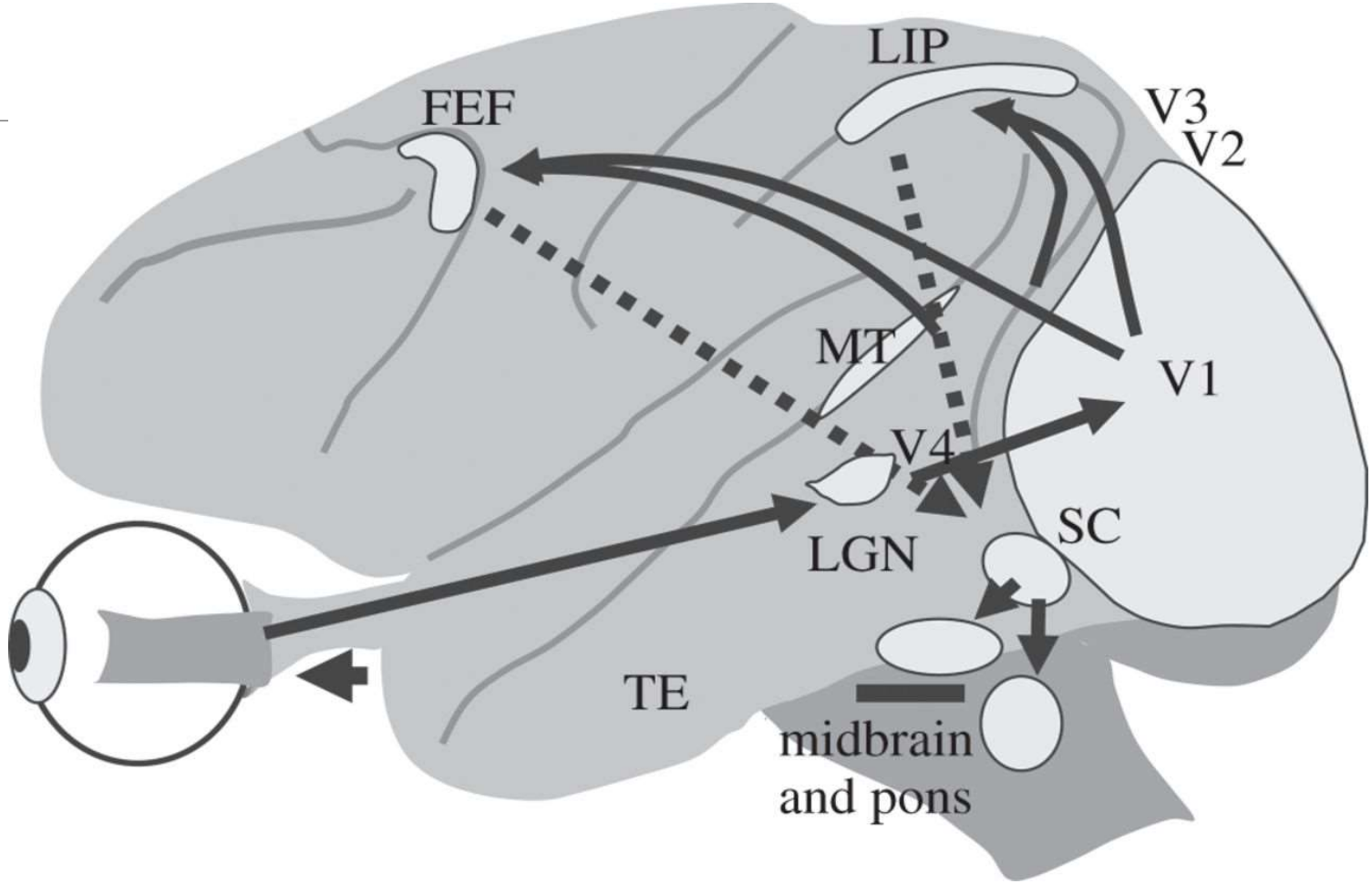
Psychology of HCI





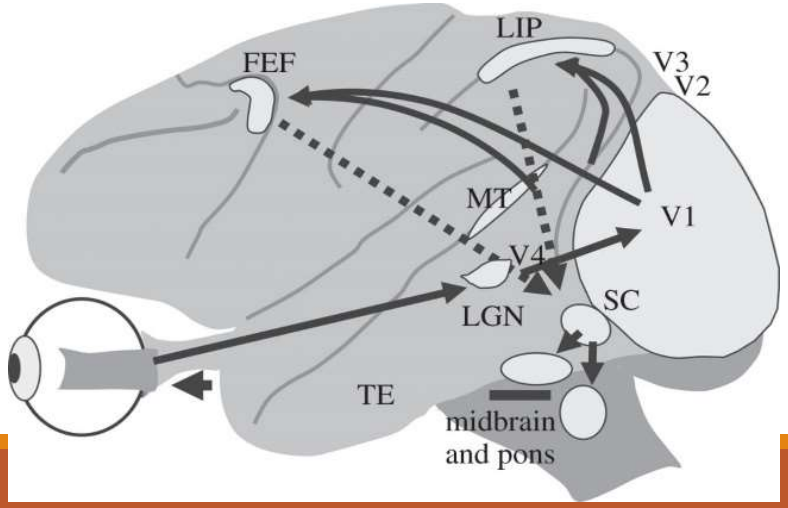
What is happening inside?

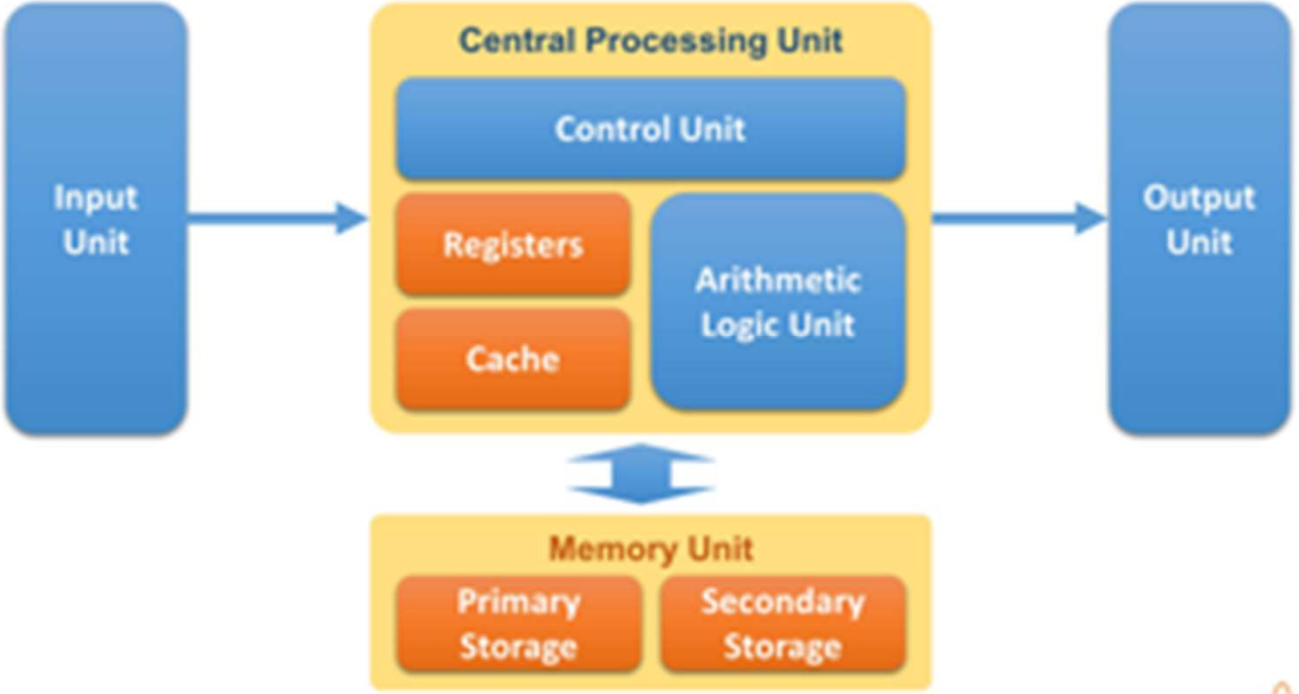


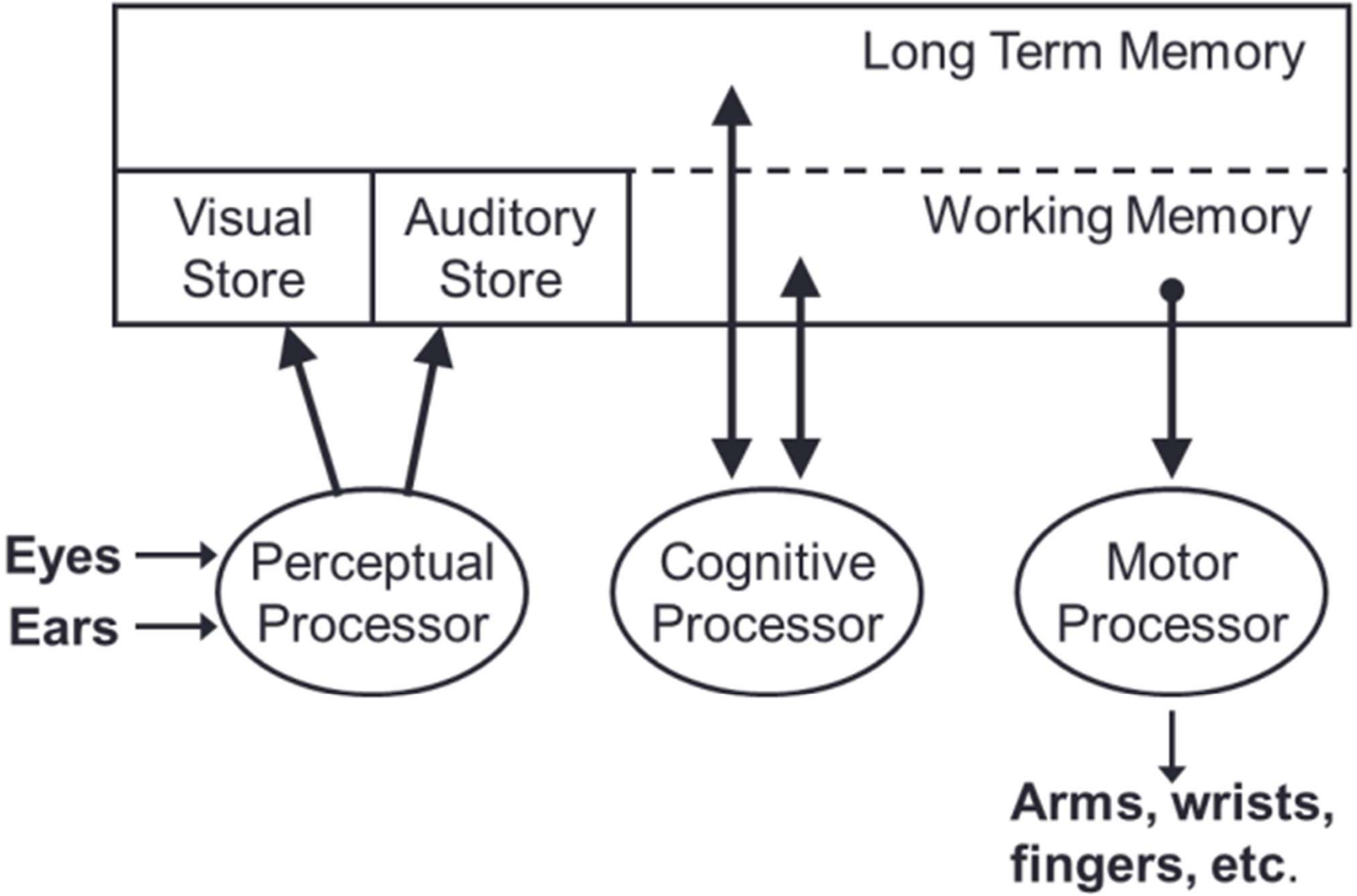


Hardware vs Wetware

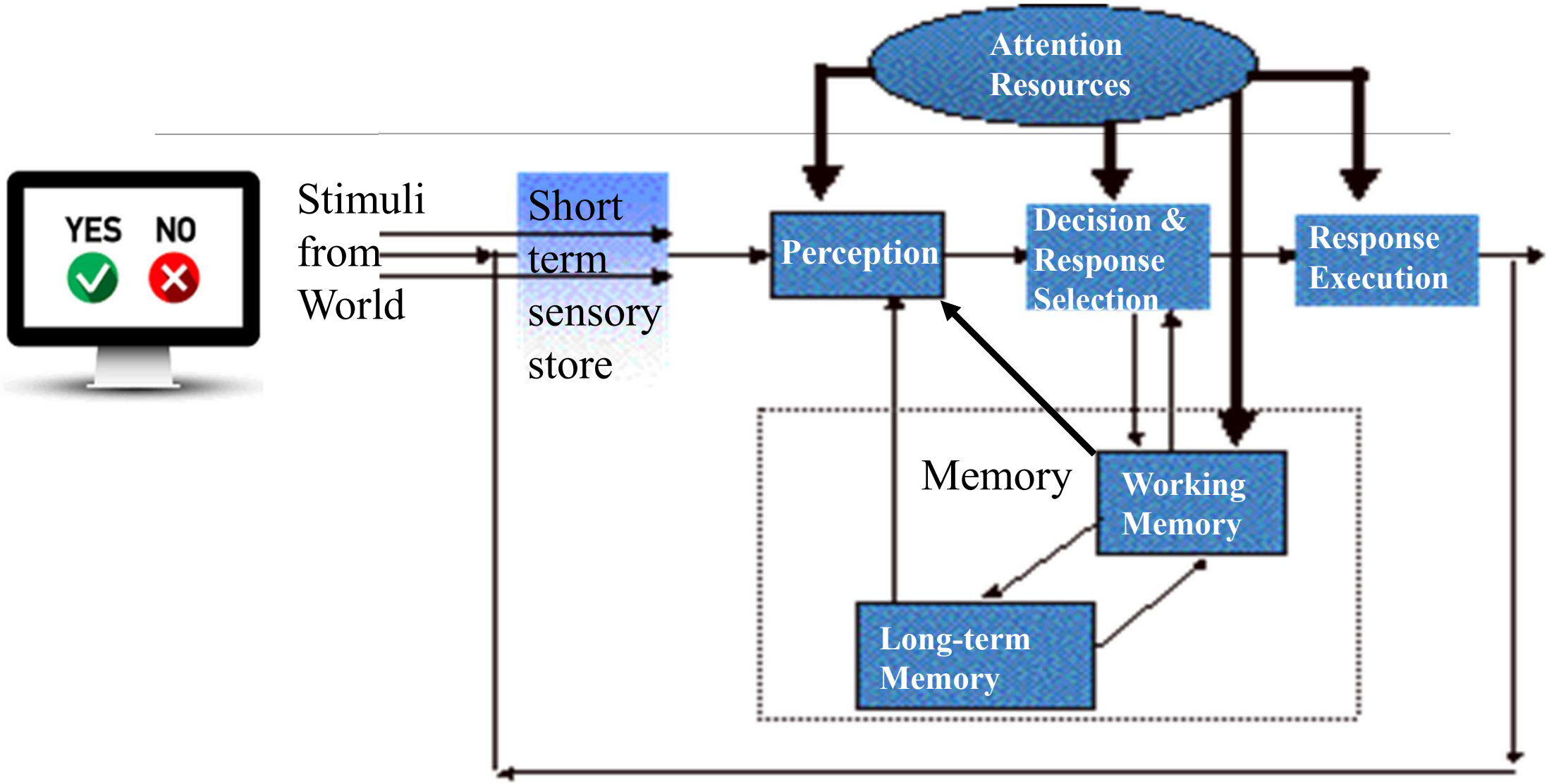
- A computer is an Information Processing System (IPS)
- The human mind is also an Information Processing System
  - Perceptual system/processor
  - Motor system/processor
  - Cognitive system/processor
- Model Human Processor



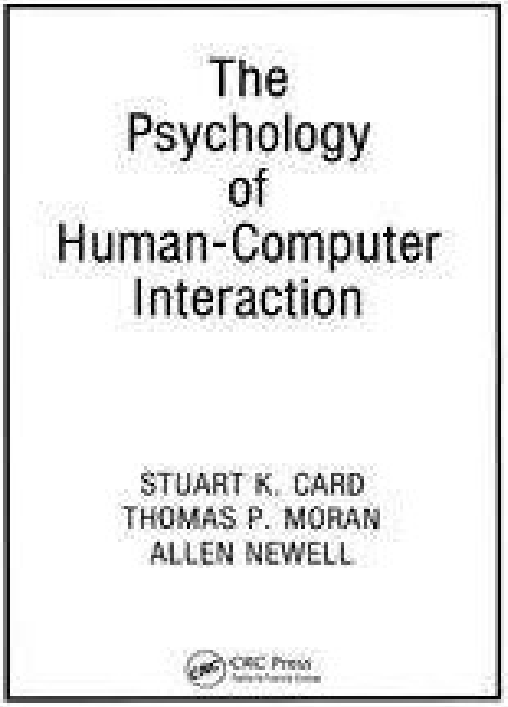


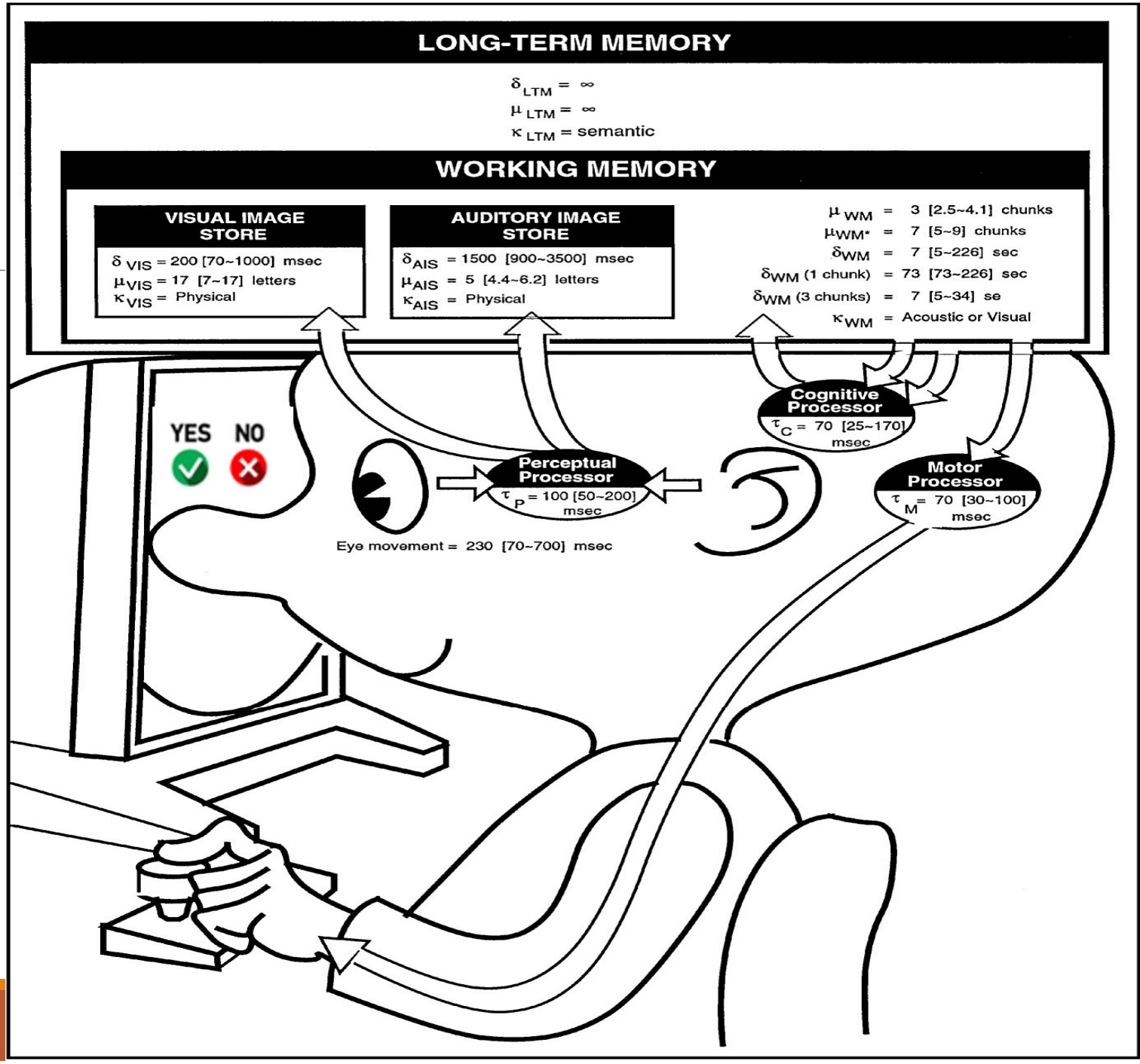

Long Term Memory
Visual Store
Auditory Store
Working Memory
Eyes
Ears
Perceptual Processor
Cognitive Processor
Motor Processor
Arms, wrists, fingers, etc.

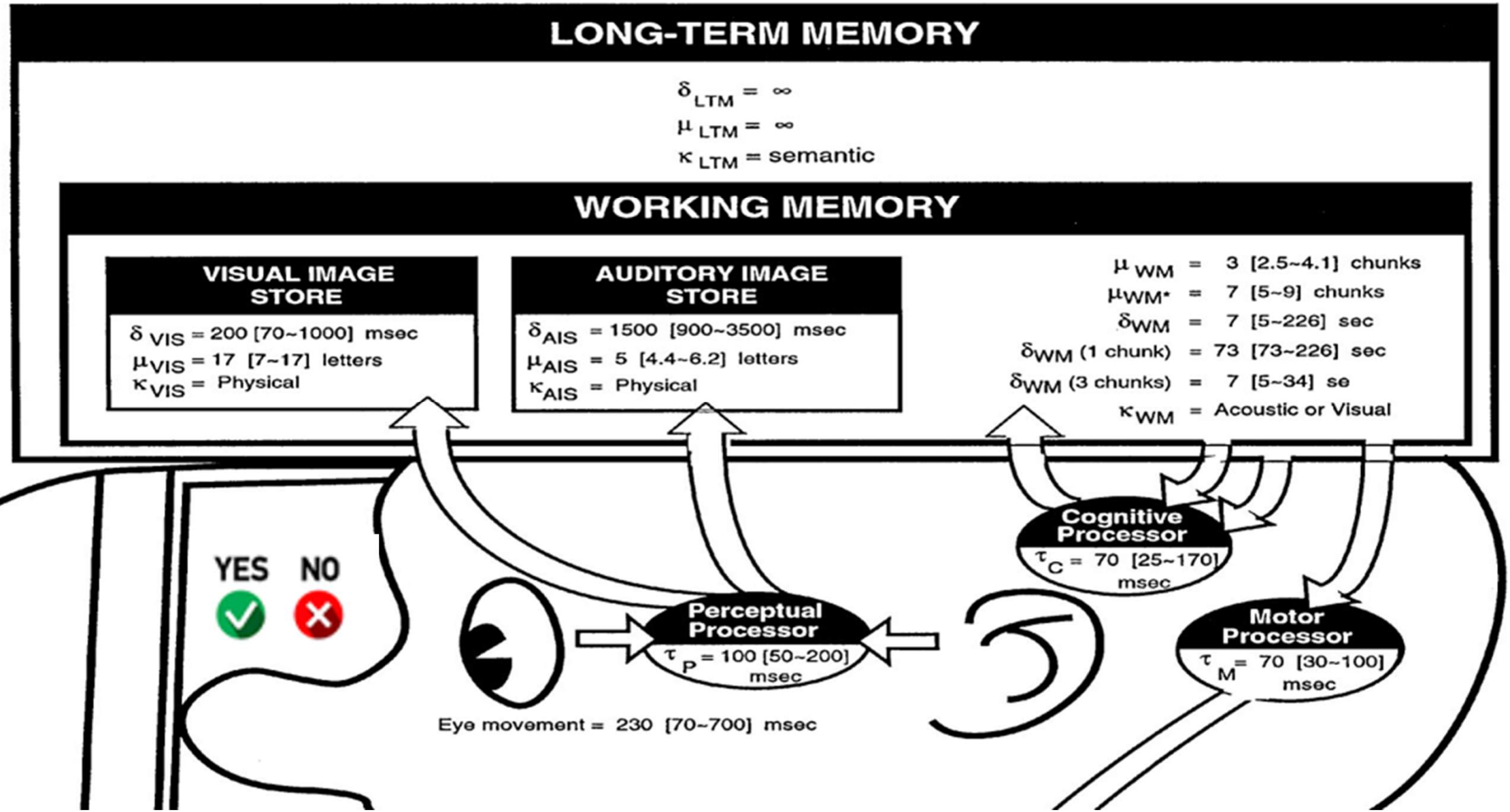
Wickens (1992)



The Model Human Processor






LONG-TERM MEMORY
$\delta_{LTM} = \infty$
$\mu_{LTM} = \infty$
κ_{LTM} = semantic
WORKING MEMORY
VISUAL IMAGE STORE
δ_{VIS} = 200 [70~1000] msec
μ_{VIS} = 17 [7~17] letters
κ_{VIS} = Physical
AUDITORY IMAGE STORE
δ_{AIS} = 1500 [900~3500] msec
μ_{AIS} = 5 [4.4~6.2] letters
κ_{AIS} = Physical
μ_{WM} = 3 [2.5~4.1] chunks
μ_{WM^*} = 7 [5~9] chunks
δ_{WM} = 7 [5~226] sec
δ_{WM} (1 chunk) = 73 [73~226] sec
δ_{WM} (3 chunks) = 7 [5~34] se
κ_{WM} = Acoustic or Visual
YES
NO
Cognitive Processor
τ_C = 70 [25~170] msec
Perceptual Processor
τ_P = 100 [50~200] msec
Motor Processor
τ_M = 70 [30~100] msec
Eye movement = 230 [70~700] msec

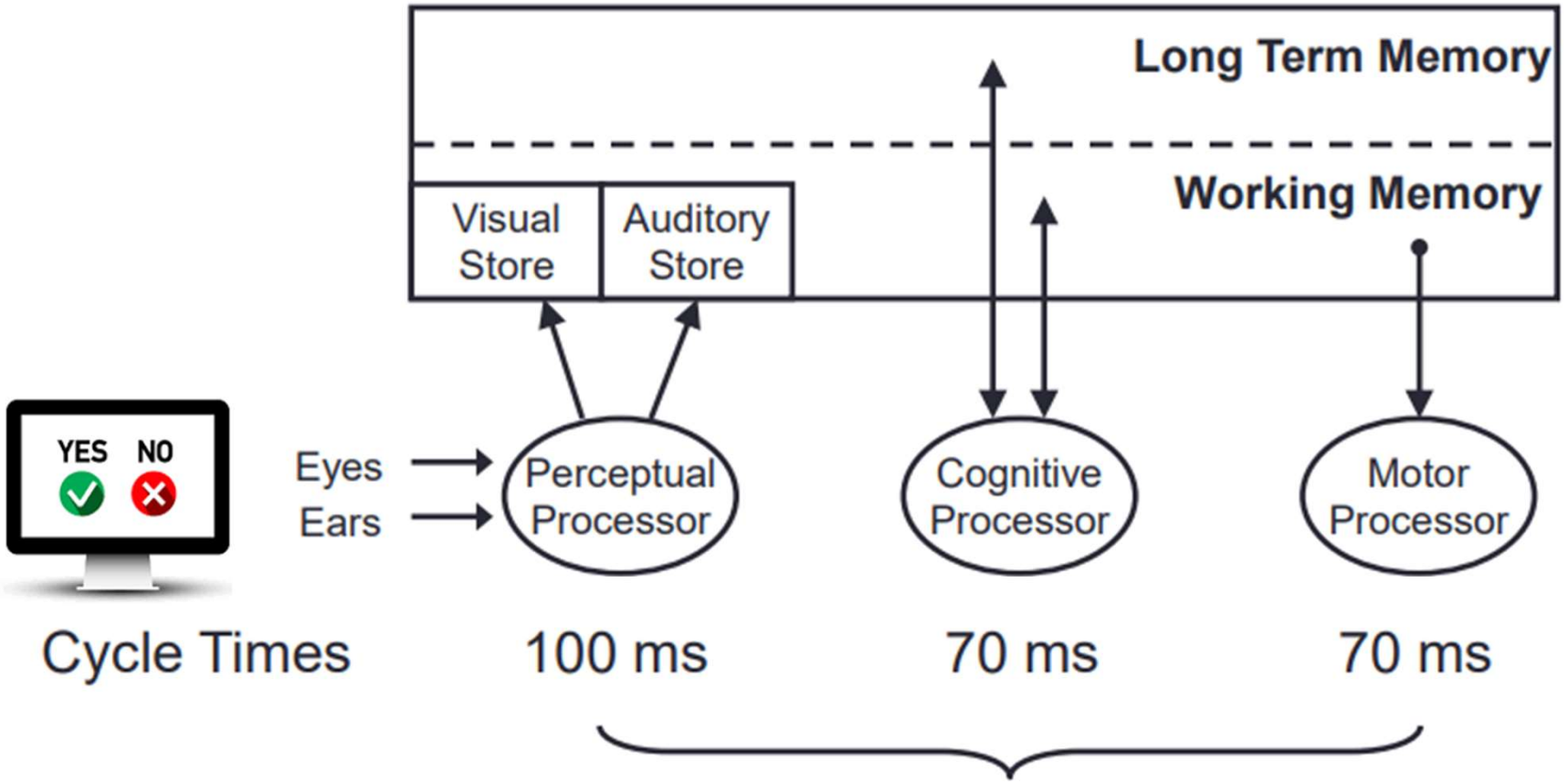
Parameters of a memory and processor

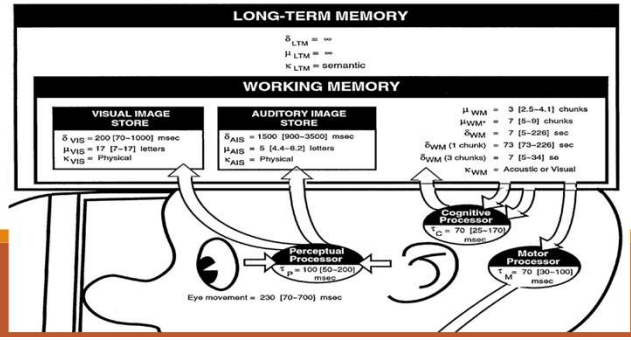
μ = Storage capacity (letter, chunk, etc.)

δ = Decay time (msec)

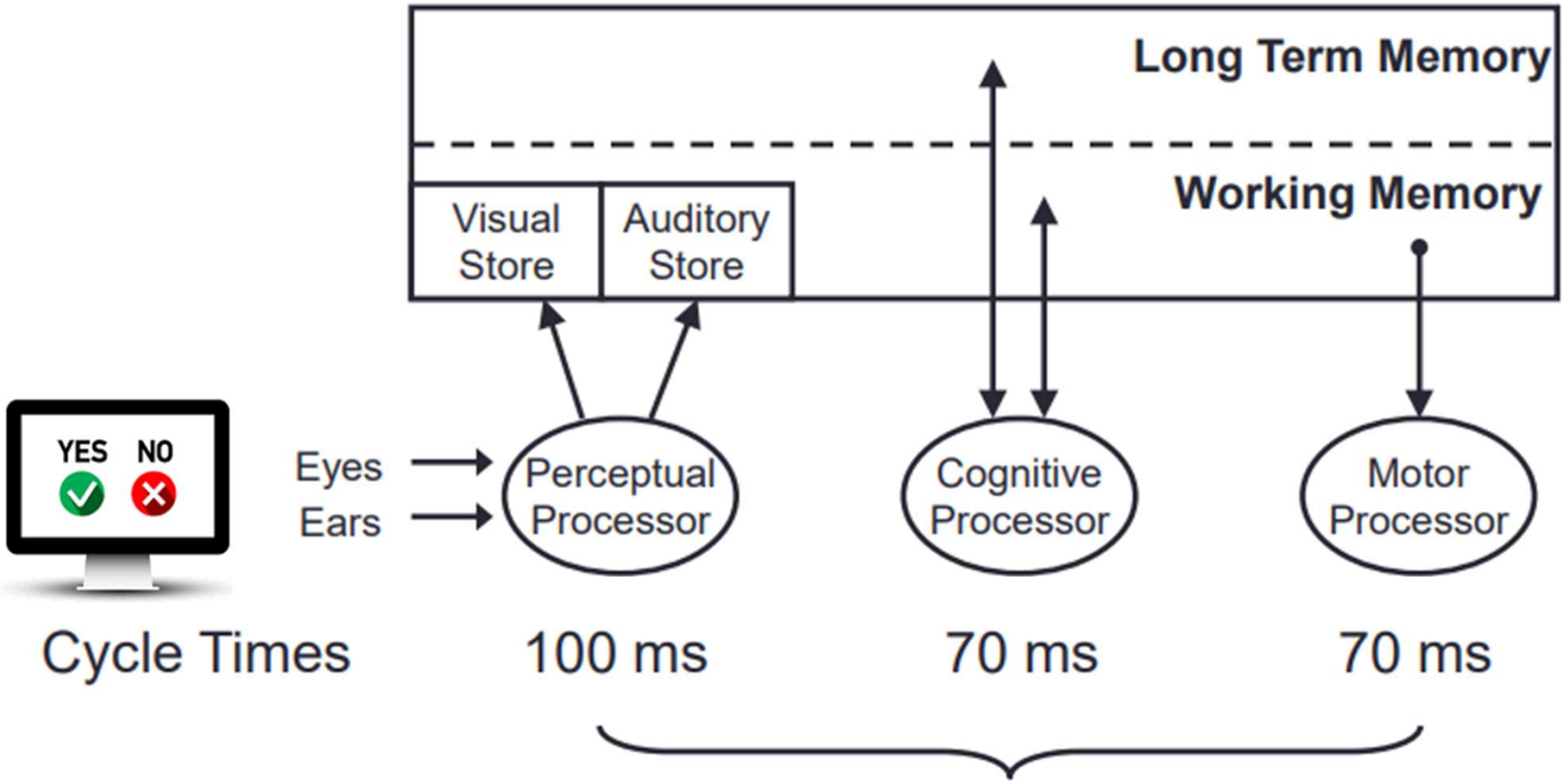
κ = Code type (physical, visual, auditory, semantic)

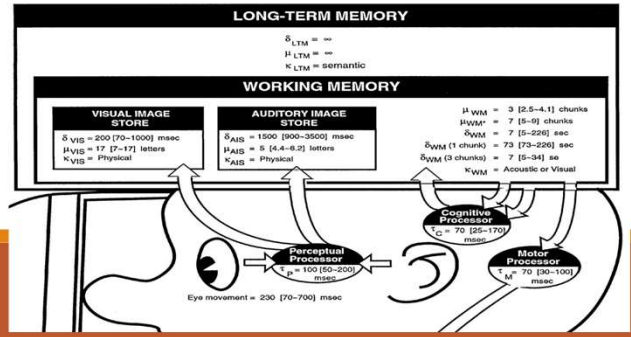
τ = Cycle time (msec)


Long Term Memory
Working Memory
Visual Store
Auditory Store
YES
NO
Eyes
Ears
Perceptual Processor
Cognitive Processor
Motor Processor
Cycle Times
100 ms
70 ms
70 ms
Perceive-Recognize-Act cycle ~= 240 ms


LONG-TERM MEMORY
WORKING MEMORY
VISUAL IMAGE STORE
AUDITORY IMAGE STORE
Perceptual Processor
Cognitive Processor
Motor Processor
Eye movement = 230 [70–700] msec

If the result is correct, raise your hand


Long Term Memory
Working Memory
Visual Store
Auditory Store
YES
NO
Eyes
Ears
Perceptual Processor
Cognitive Processor
Motor Processor
Cycle Times
100 ms
70 ms
70 ms
Perceive-Recognize-Act cycle ~= 240 ms


LONG-TERM MEMORY
WORKING MEMORY
VISUAL IMAGE STORE
AUDITORY IMAGE STORE
Perceptual Processor
Cognitive Processor
Motor Processor
Eye movement = 230 [70–700] msec

Basic properties of all users

- Changes with experience
- Actively learns
- Limited attention (esp. Children)
- Makes mistakes
- Models the system in their mind
- Remains unique
- Goal oriented

Hi! Sign in or register Daily Deals Help & Contact Ship to Sell Watchlist My eBay

ebay Shop by category Search for anything All Categories Search Advanced

Back to home page | Listed in category: Clothing, Shoes & Accessories > Men > Men's Shoes > Athletic Shoes Share | Add to Watchlist

SAVE UP TO 50% See all eligible items and terms

PUMA Men's Tazon Advance Bold Sneakers

20 sold in last 24 hours

Condition: New with box

US Shoe Size: - Select -

Color: - Select -

Quantity: 1 Limited quantity available / 525 sold

Price: **US $33.99**

List price ~~US $70.00~~

Save US $36.01 (51% off)

Buy It Now

Add to cart

Add to watchlist

This one's trending. 525 have already sold.

Breathe easy. Returns accepted.

Shipping: US $19.74 eBay International Shipping . See details

Located in: United States, United States

This item may be subject to duties and taxes upon delivery

Delivery: Estimated between Thu, Dec 14 and Thu, Jan 4 to 34365

Shop with confidence

Direct from Puma
Item sold directly by the brand.

Top Rated Plus
Trusted seller, fast shipping, and easy returns.
Learn more

eBay Money Back Guarantee
Get the item you ordered or your money back.
Learn more

PUMA

Shop PUMA on eBay

98.5% positive feedback

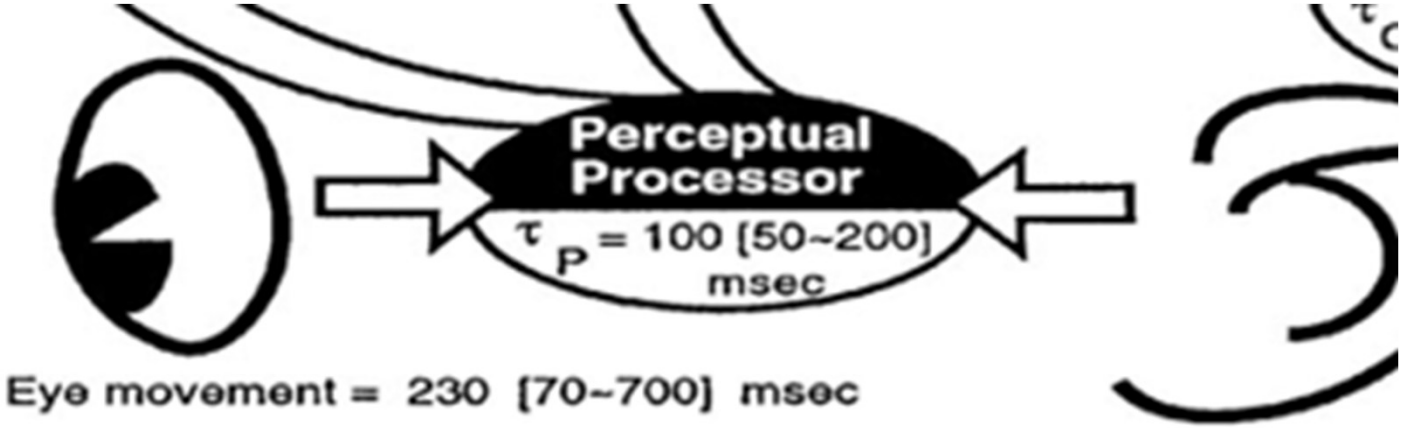
Save seller

Contact seller

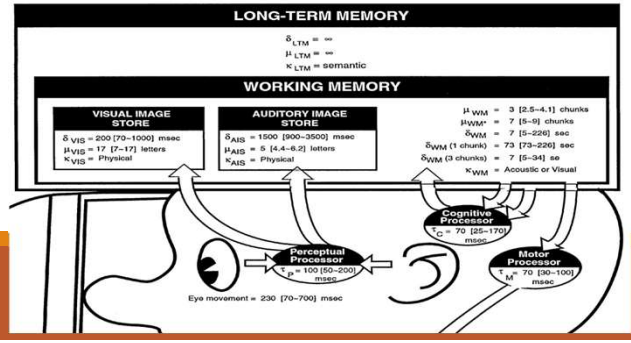
See other items

What can you tell about it?

τ_p = 100 ms (Cycle time for perceptual proc)



Also, Short Term Sensory Store mechanism

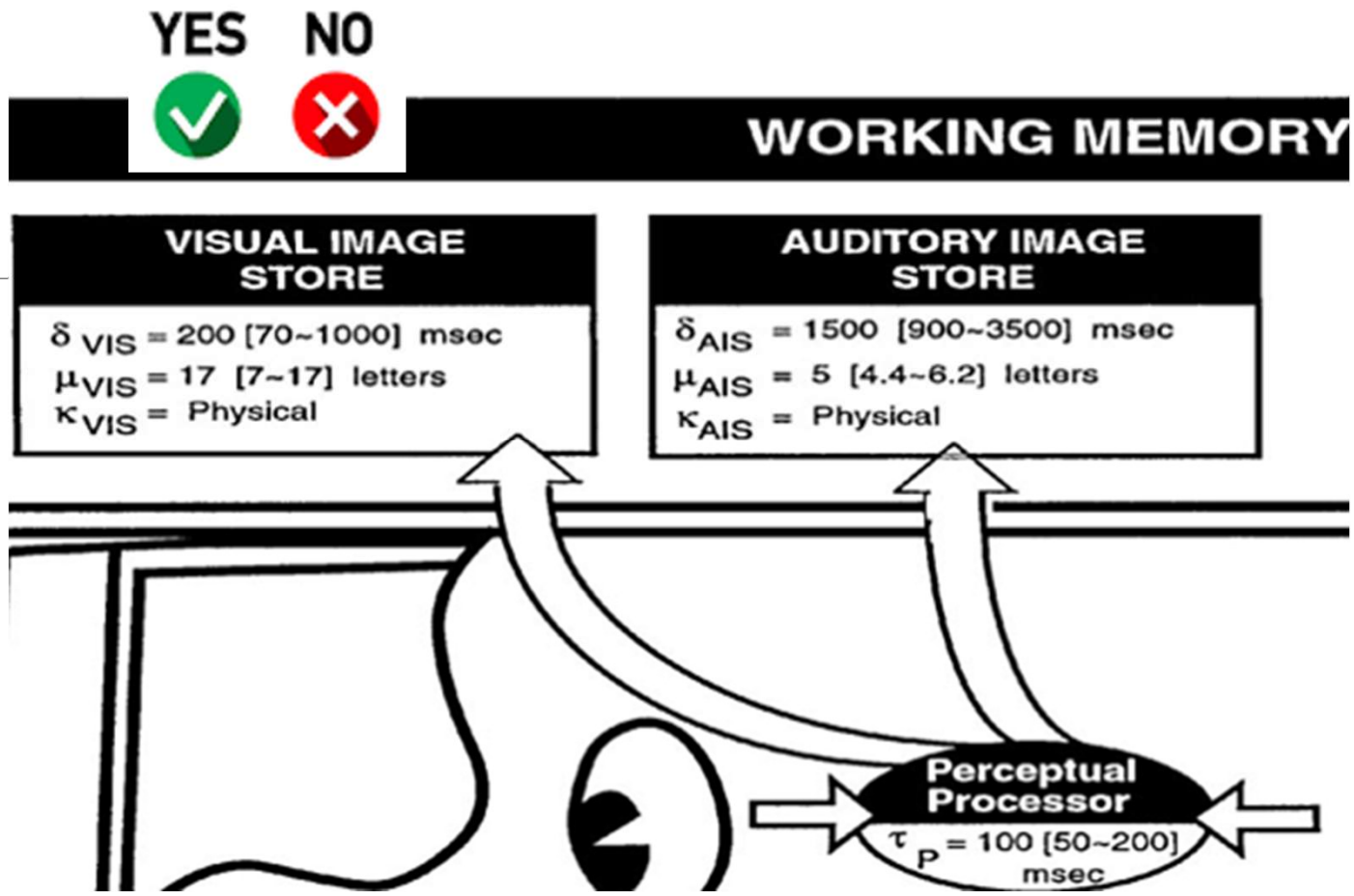


Visual

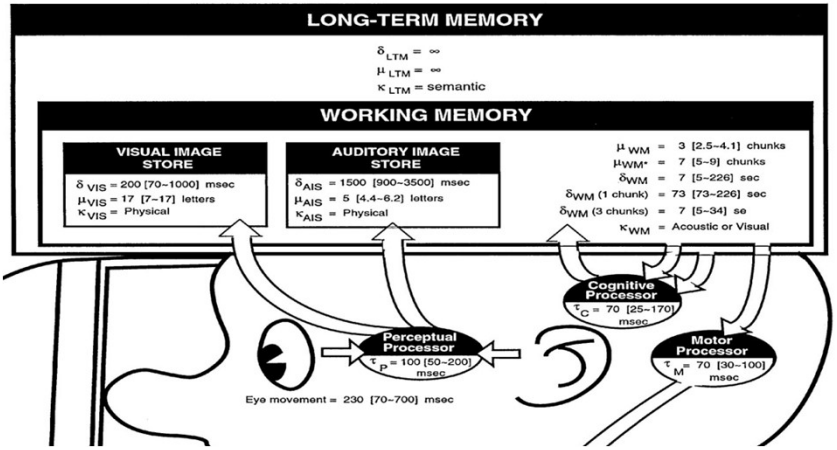
- δ_{vis} = 200ms (decay)
- μ_{vis} = 17 letters
- κ_{vis} = Physical

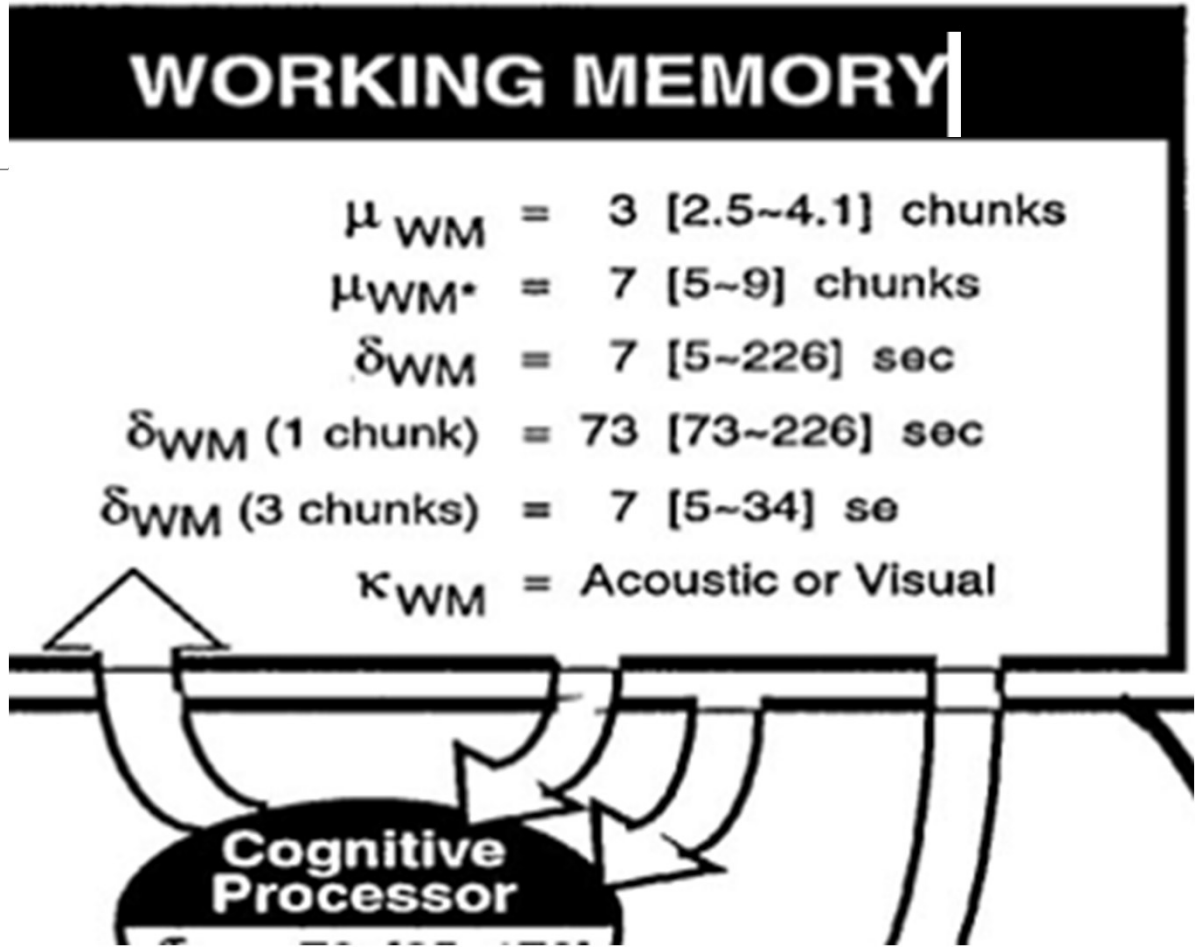
Auditory

- δ_{AIS} = 1500ms (decay)
- μ_{AIS} = 5 letters
- κ_{AIS} = Physical



- μ_{wm} = 7+/-2 chunks
- δ_{wm} = 7 sec (decay)



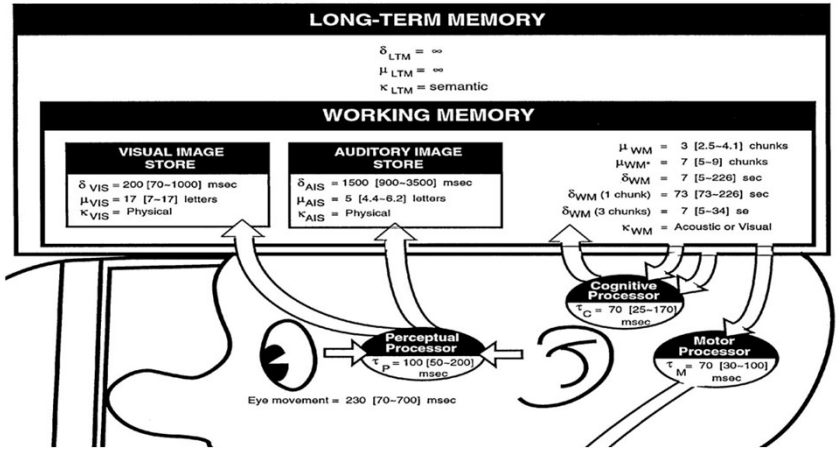


LONG-TERM MEMORY

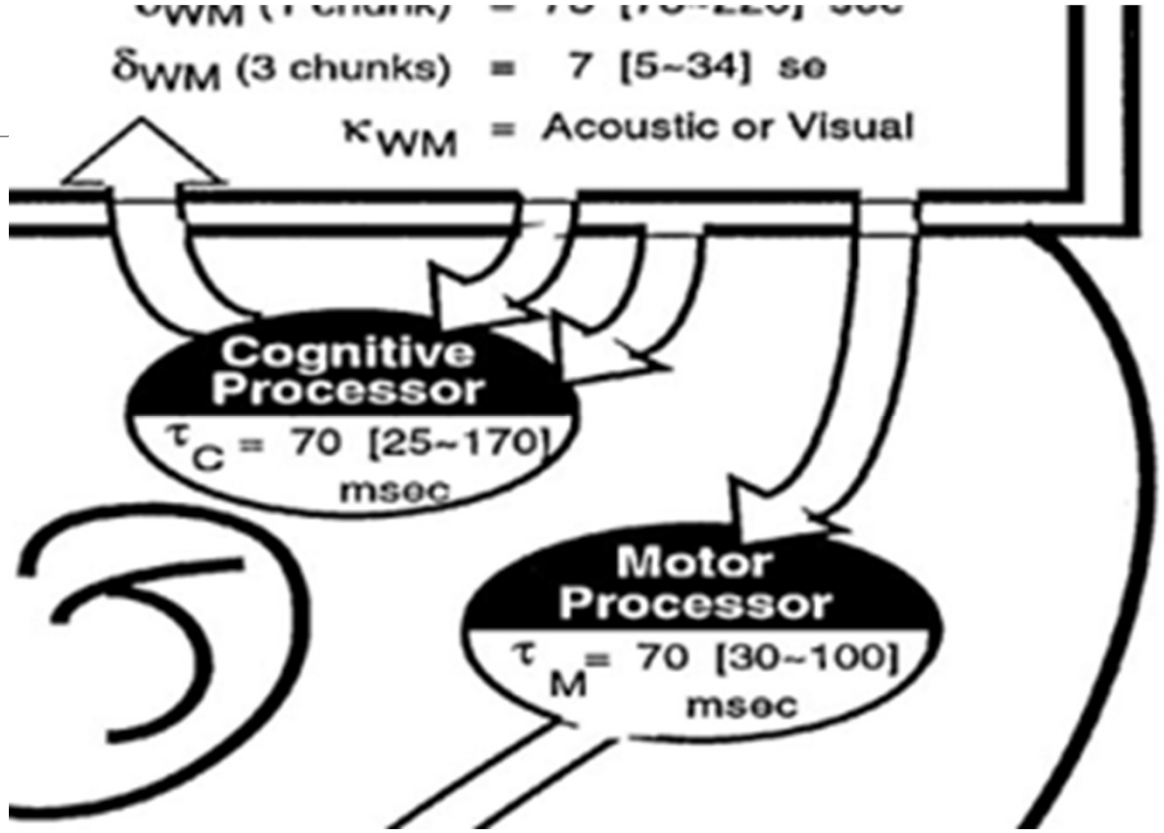
$$\delta_{LTM} = \infty$$

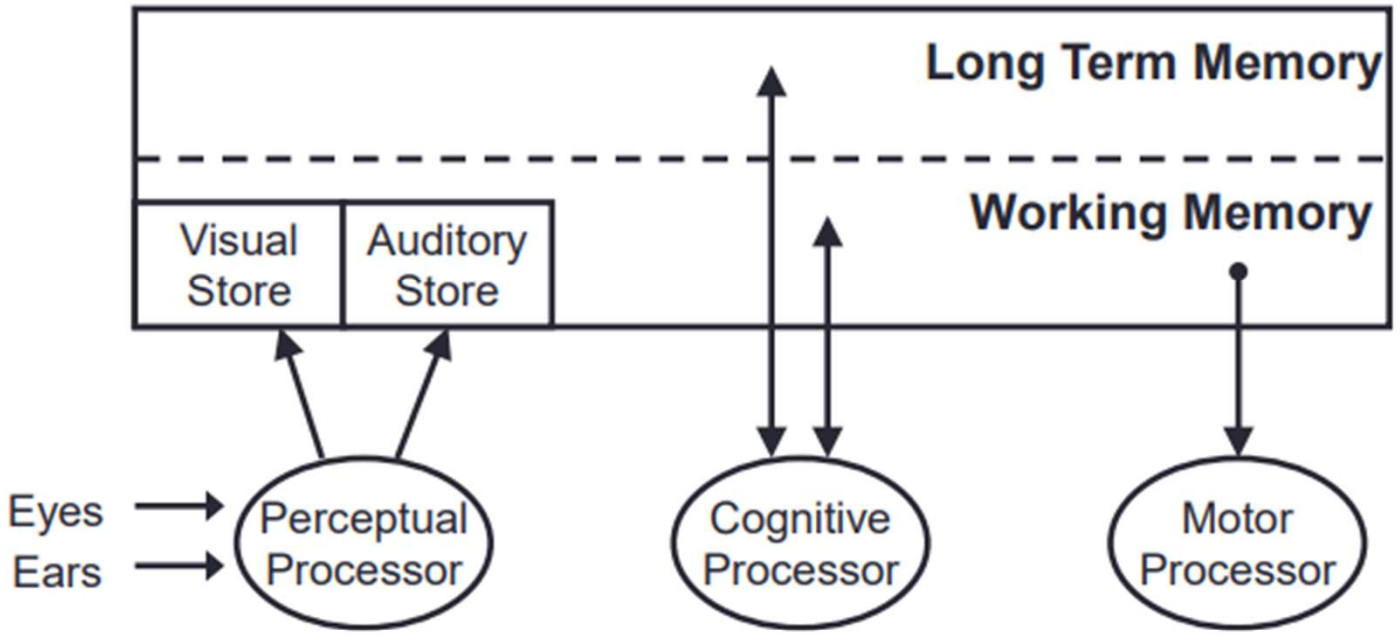
$$\mu_{LTM} = \infty$$

$$\kappa_{LTM} = \text{semantic}$$



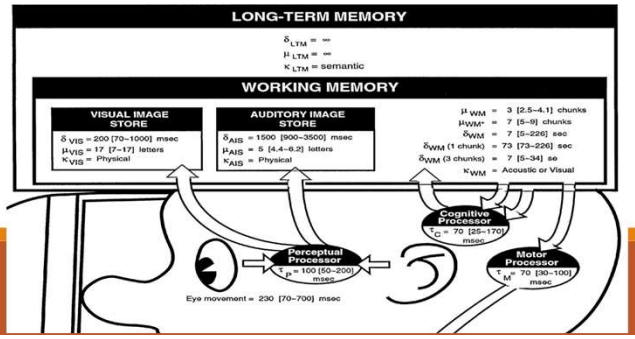
- τ_C = 70 (Cycle time, ms)
- Depending on task:
  - letters 40 ms,
  - words 47ms,
  - 3D shapes 94 ms

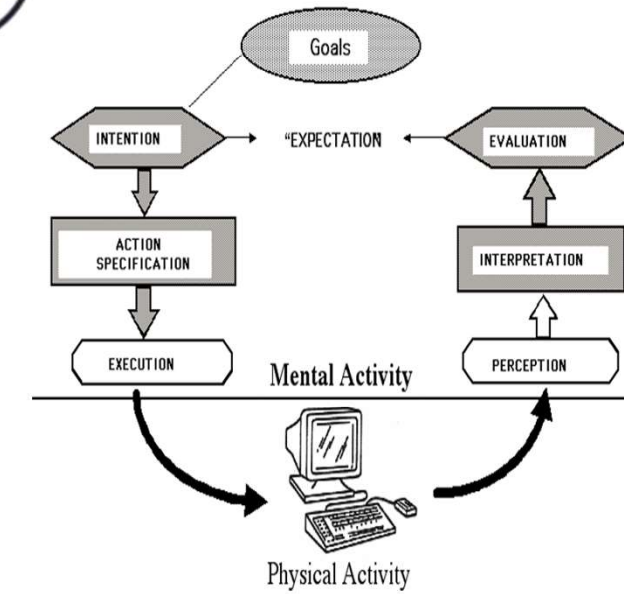




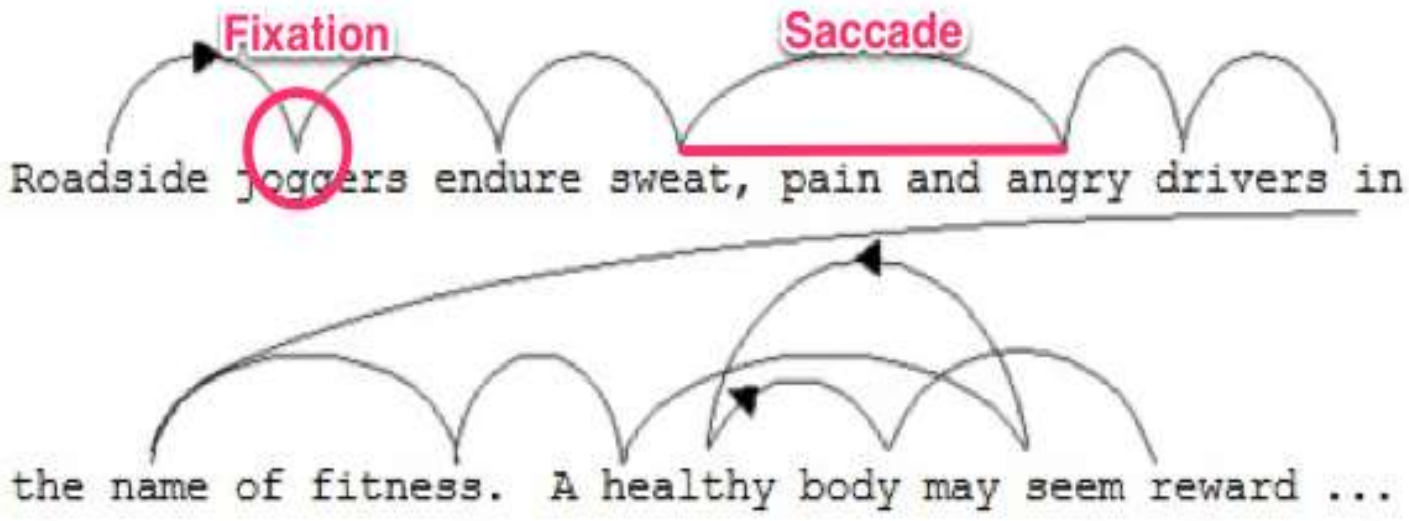
Cycle Times 100 ms 70 ms 70 ms

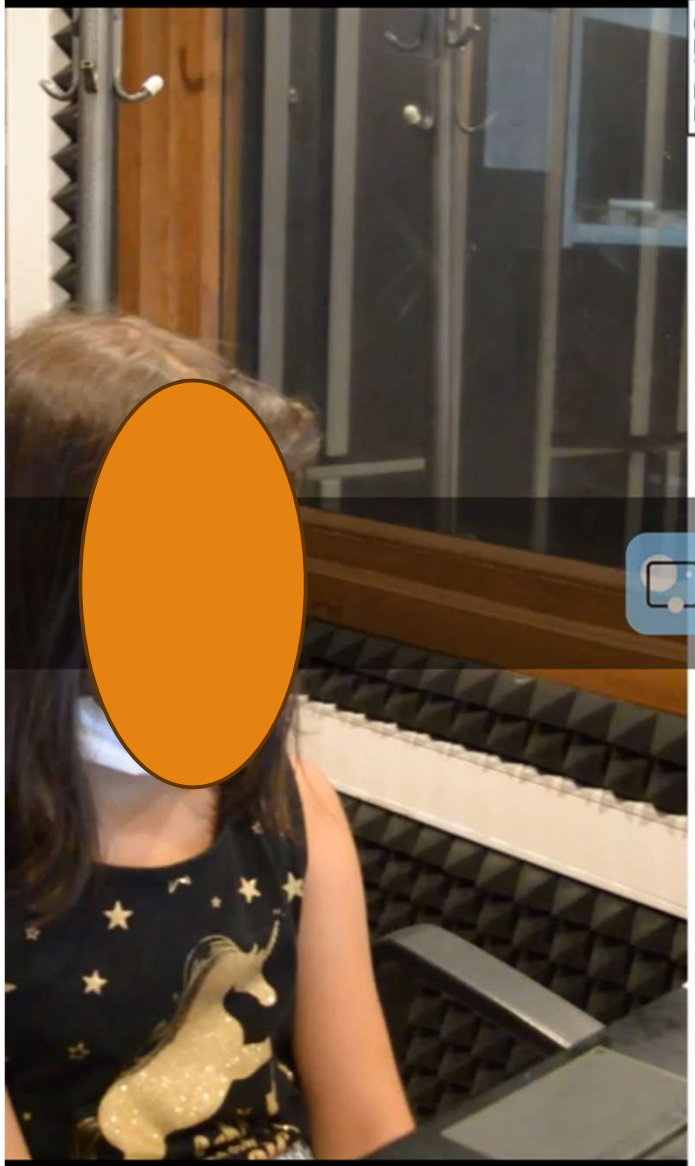
Perceive-Recognize-Act cycle ~= 240 ms





Example: How fast do we read? Wpm?





GazePlot
Media: 2Final.png
Time: 00:00:00,000 - 00:02:24,884
Participant filter: All Participants
Number of participants included: 1/5 (20%)

Gamze ve Arkadaşı

Cumartesi günü hava çok güzeldi. Gamze sabah ödev yaptı, sonra biraz kitap okudu. Öğleden sonra canı sıkıldı. O sırada kapı çaldı, Gamze çok sevindi. Hemen koştu ve kapıyı açtı. Arkadaşı Ece gelmişti. Ece:

- Beraber parka gidelim mi? diye sordu. Gamze sevinçle:
- Hemen gidelim, ama önce annemden izin alayım, dedi.

Gamze annesinden izin aldı. Gamze ve Ece parka gittiler. Parkta birçok çocuk vardı. Gamze önce salıncağa binmek istedi. Birlikte salıncağa bindiler, sonra kaydıraktan kaydılar. Birden yağmur yağmaya başladı. Gamze ve Ece ıslandılar, koşarak eve gittiler. Gamze'nin annesi onlara kuru giysiler verdi, çay ve pasta ikram etti. Çocuklar çay içtiler, pasta yediler. Sonra Gamze oyuncaklarını çıkarttı, onlar akşama kadar beraber oynadılar.

Akşam olunca Ece eve gitti. Çocuklar cumartesi günü çok eğlendiler.

Gamze ve Arkadaşı

Cumartesi günü hava çok güzeldi. Gamze sabah ödev yaptı, sonra biraz kitap okudu. Öğleden sonra canı sıkıldı. O sırada kapı çaldı, Gamze çok sevindi. Hemen koştu ve kapıyı açtı. Arkadaşı Ece gelmişti. Ece:

- Beraber parka gidelim mi? diye sordu. Gamze sevinçle:
- Hemen gidelim, ama önce annemden izin alayım, dedi.

Gamze annesinden izin aldı. Gamze ve Ece parka gittiler. Parkta birçok çocuk vardı. Gamze önce salıncağa binmek istedi. Birlikte salıncağa bindiler, sonra kaydıraktan kaydılar. Birden yağmur yağmaya başladı. Gamze ve Ece ıslandılar, koşarak eve gittiler. Gamze'nin annesi onlara kuru giysiler verdi, çay ve pasta ikram etti. Çocuklar çay içtiler, pasta yediler. Sonra Gamze oyuncaklarını çıkarttı, onlar akşama kadar beraber oynadılar.

Akşam olunca Ece eve gitti. Çocuklar cumartesi günü çok eğlendiler.

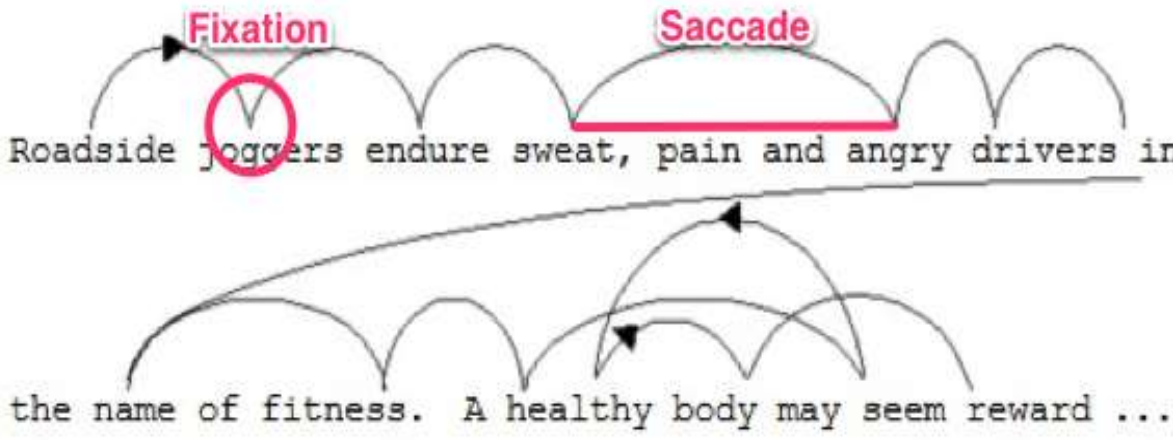
Example: How fast do we read

- Slow reader-kids:

$$\frac{\text{60 sec (1 min)}}{\text{0.230sec * 5 saccade/word}} = \text{52 wpm}$$

- Normal reader:

$$\frac{\text{60 sec (1 min)}}{\text{0.230sec * 1 saccade/word}} = \text{261 wpm}$$



- What if someone makes 400 wpm ?

Eye Fixations biased towards start of words:

_he ____tion _f ____tions ___ies _n ___ding

As opposed to:

Th_ loca____ o_ fixa_____ var___ i_ rea____

Fi yuo cna raed tihs, yuo hvae a sotnrg mnid.
Sduties swohs taht popele wtih an inegltlience
lveel aovbe namrol cna raed wrods wohitut hvaing
teh ltetres in teh crorcet oedrr.
In fcat, olny teh fsrit adn teh lsat leterts nedes to be
in pcale, tehn yuor brian wlil tkae crae of teh rset.
If yuo can raed tihs, **share it**.

İgnliiz Üineveerdtlserinin bir tensai hrarlefin hgnai salıyra dmiziilş olğunduun öemnisz oludğnuu oayrta kydou. Bduara tek ömlnei ntoka ilk ve son hfiarn dğrou ydere osmldaıır. Gsreii tmaamen salmçaık olbaiilr, ve sen ynie de pbromlseiz okyailusbirin.Bu haeflrri hraf oralak okumzdaımdğıan ve kmellireei büütn oalark alamıdılgzdığıan kanakyanlır.

Reading as Perceptual chunking

- Most words are fixated at least partially
- Need to fixate closely (less than 10 characters taken in per fixation)
- Unusual words are fixated longer
- Skilled readers fixate and regress less

Typing?

Cognitive parameters

From: Olson and Olson, 1990

Name	Action	Time (msec)
K	Enter a keystroke	230
M	Point with the mouse	1500
Hm	Move hands to mouse	360
P	Perceive	100
R	Retrieve from memory	1200
Ex	Execute a mental step	70
Ch	Choose among methods	1250

Lets have a test

- Save a file with Wordpad
- Name of file MYFILE
- Do not use shortcuts, use mouse and keyboard
- Keep time

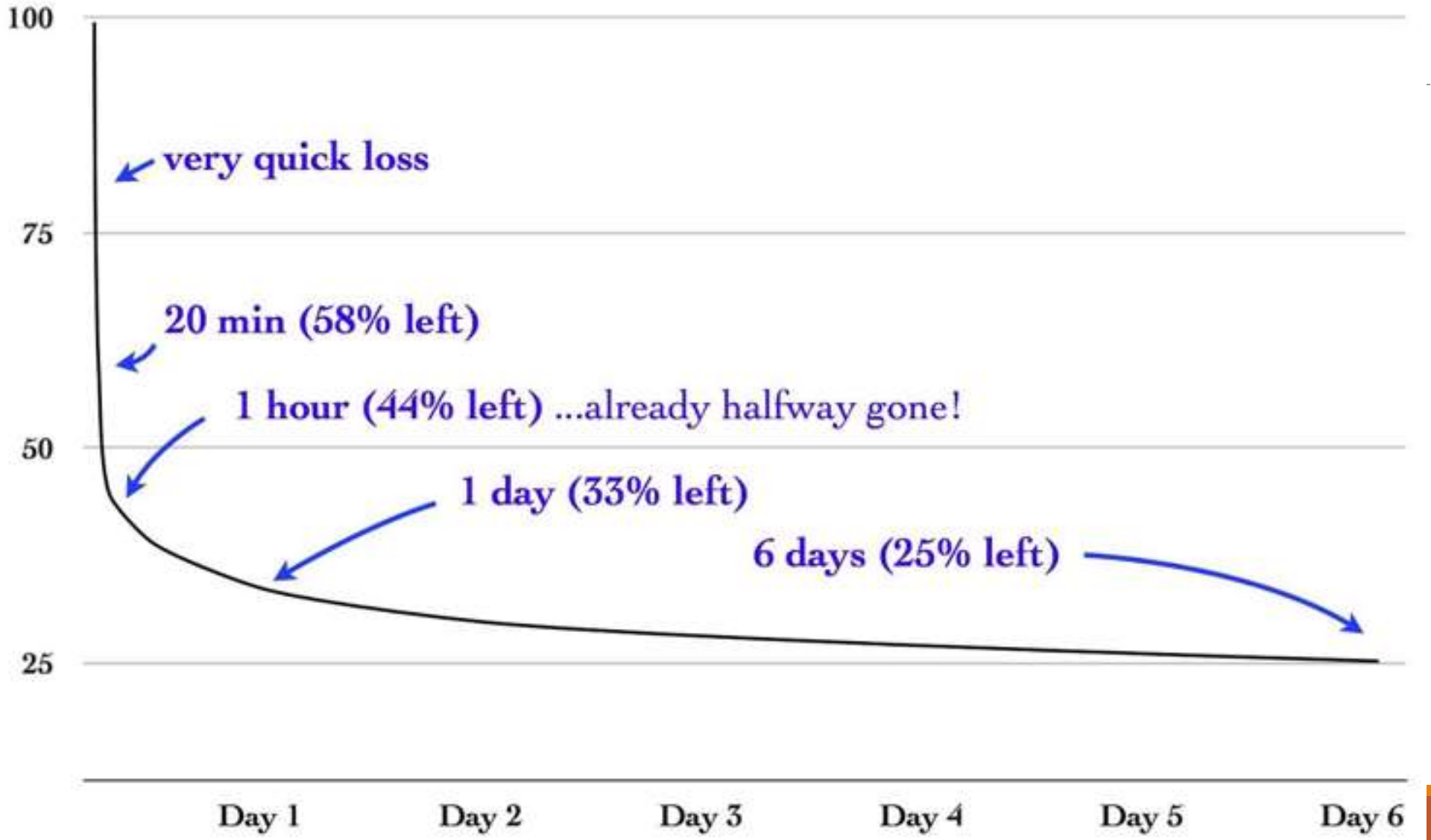
Save file <MYFILE>

Initial homing of hand	(Hm=0.36 sec)
Move cursor to file menu,	(M =1.5)
+ Retrieve from memory	(R=1.2)
Click file menu	(K =0.23)
move down menu	(M=1.5)
+ retrieve from memory	(R=1.2)
click ‘save as’	(K=0.23)
System reacts	(Sys=1.2),
user types name	(R =1.2 + (nk= 6(0.23))
and hits return	(K=0.23)
total:	10.23 secs

And forgetting – Decay - δ

WM and Ebbinghaus's Forgetting Curve

(Names)

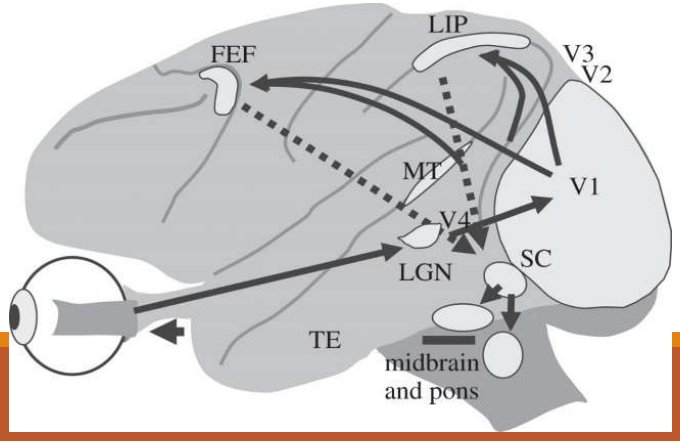


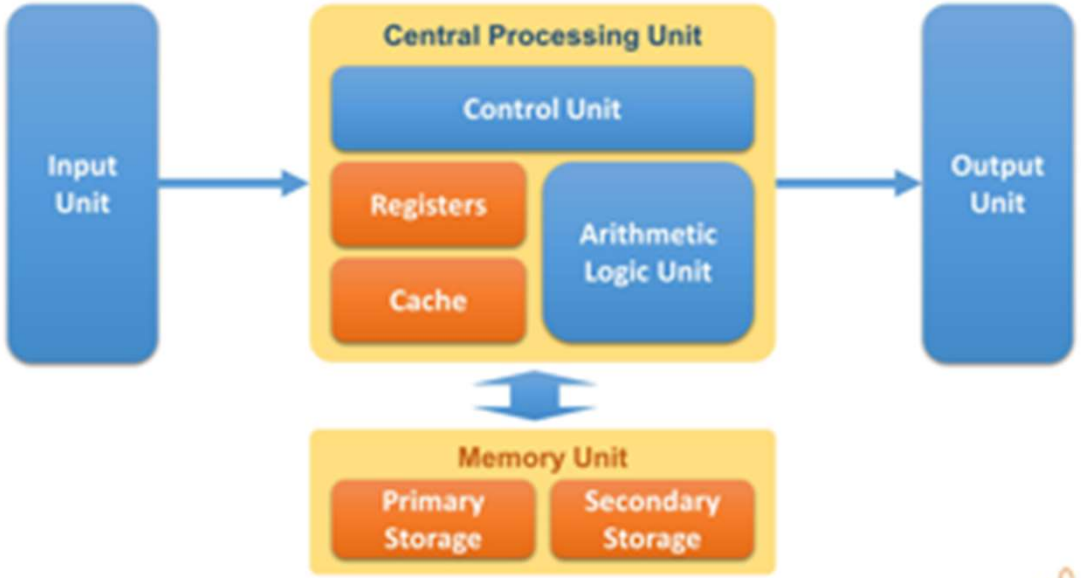
> 20 minutes passed

- Human Information Processing System
- Three processors?

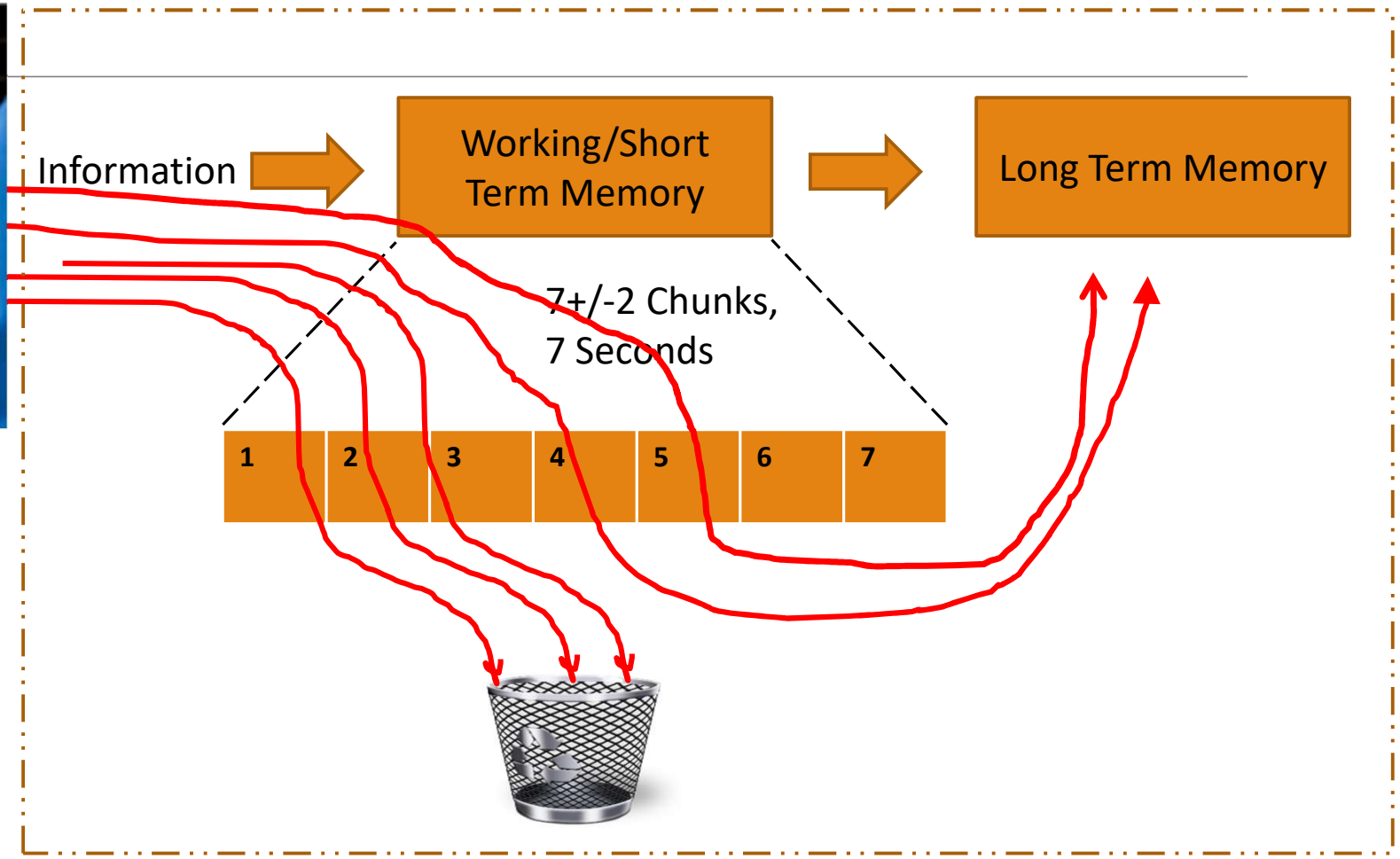
Hardware vs Wetware

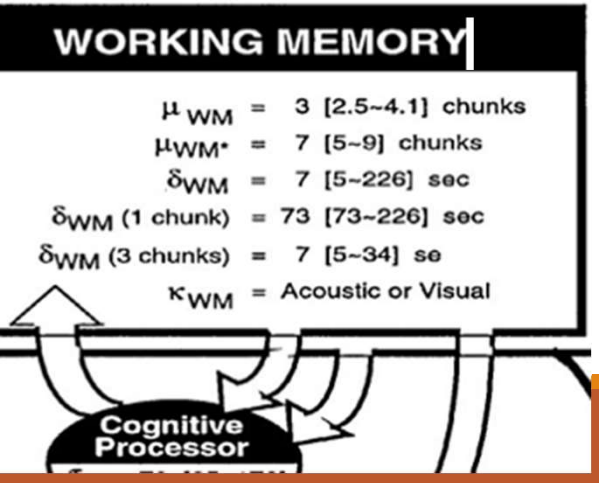
- A computer is an Information Processing System (IPS)
- The human mind is also an Information Processing System
  - Perceptual system/processor
  - Motor system/processor
  - Cognitive system/processor
- Model Human Processor





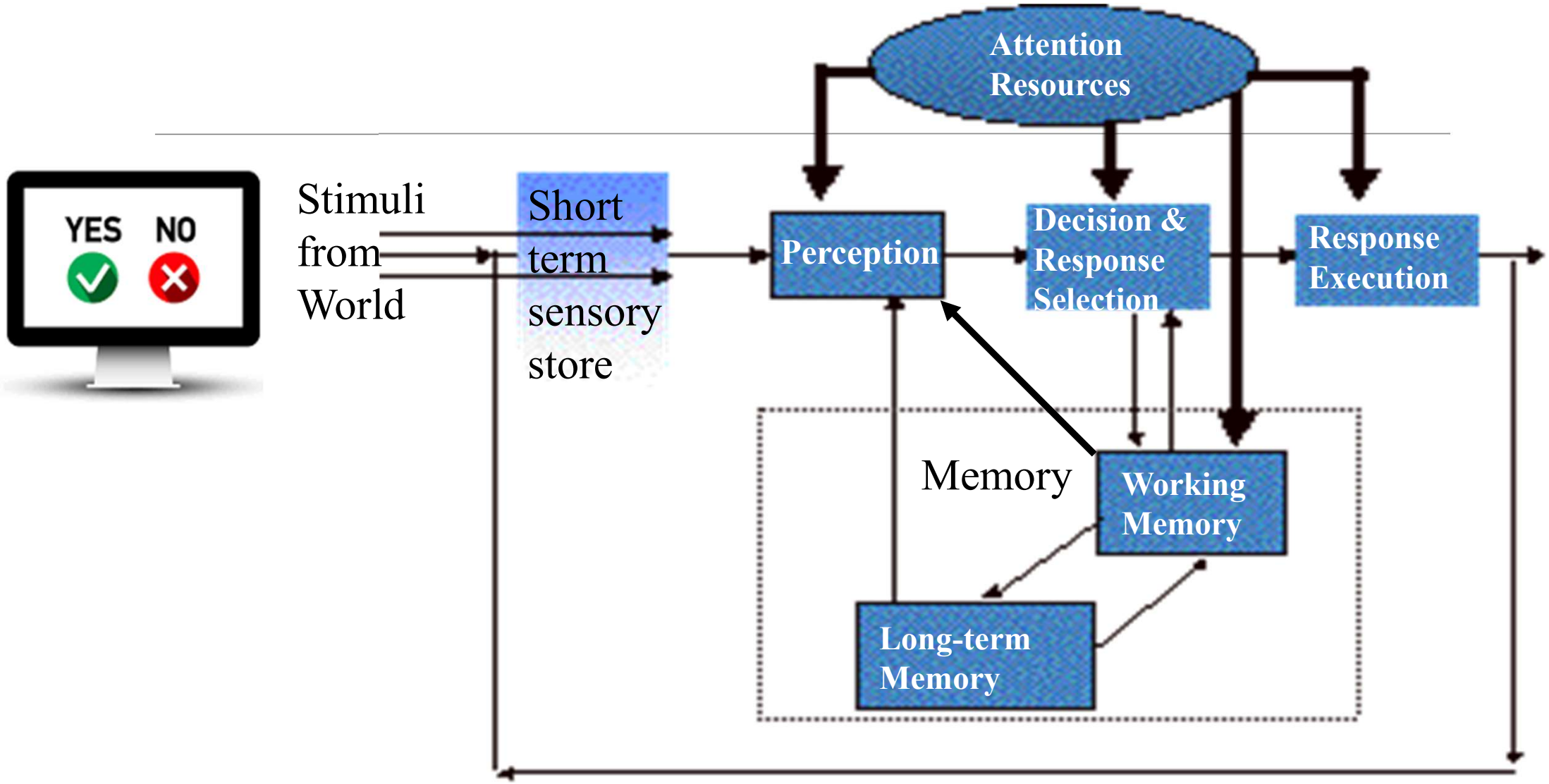
WM, LTM, Chunking, Forgetting



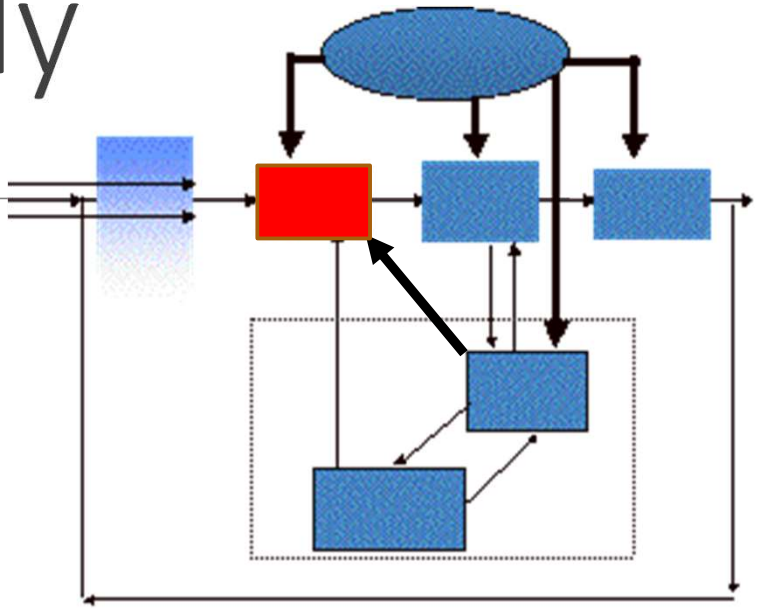


Miller, G. A. (1956). "The magical number seven, plus or minus two: Some limits on our capacity for processing information". *Psychological Review*. **63** (2): 81–97

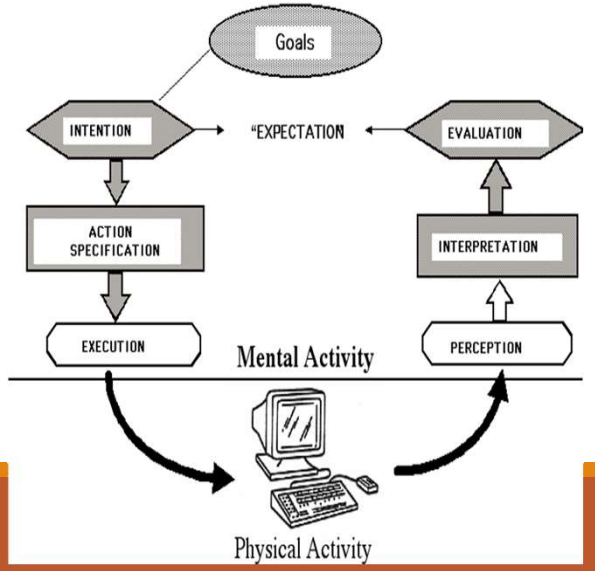
Wickens (1992)



Cognition is fast & orderly

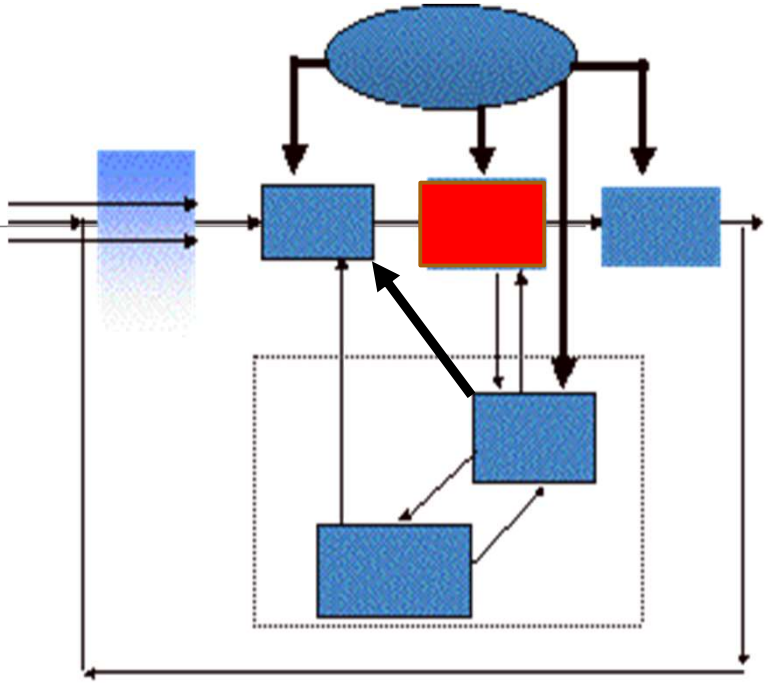


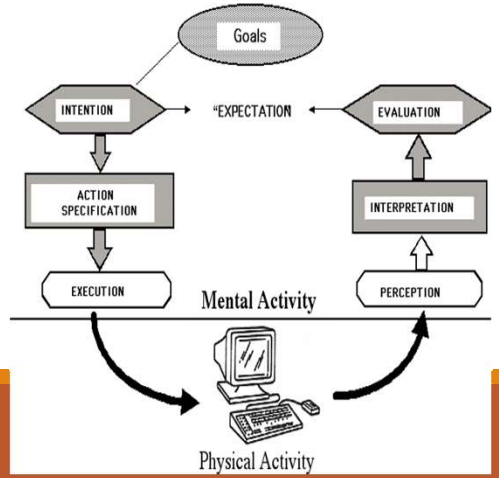
- Short-term sensory store (STSS)
  - rapidly decays (<1sec)
  - sensitive to physical characteristics of signal
  - Pre-attentive (unconscious)
- Perception
  - many-to-one category mapping
  - detection, recognition, categorization cycle
  - stimulus is consciously attended to here



And then….

- Decision and Response selection
  - Once encoded, human must react
  - Can be automatic or controlled response
- Response execution
  - Sequence of behavior follows,
- Feedback
  - We monitor events and our actions
- Attention is usually required after STSS



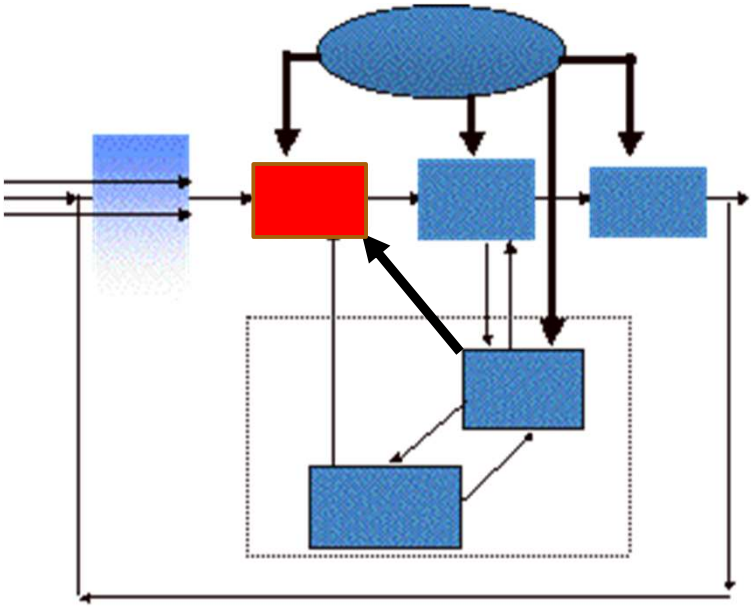


Basic attributes

- Human cognitive system consists of structures
  - memory (short and long term), schemata, etc.
- and processes
  - encoding, retrieval, assimilation etc.
- Human cognition is active:
  - we seek meaning and regularity

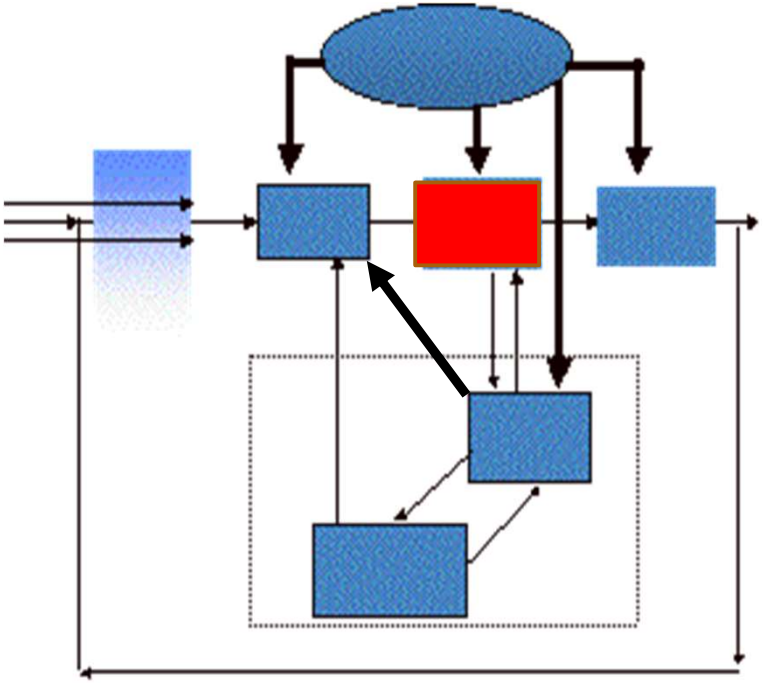
Cognition is fast & orderly

- Short-term sensory store (STSS)
  - rapidly decays (<1sec)
  - sensitive to physical characteristics of signal
  - Pre-attentive (unconscious)
- Perception
  - many-to-one category mapping
  - detection, recognition, categorization cycle
  - stimulus is consciously attended to here



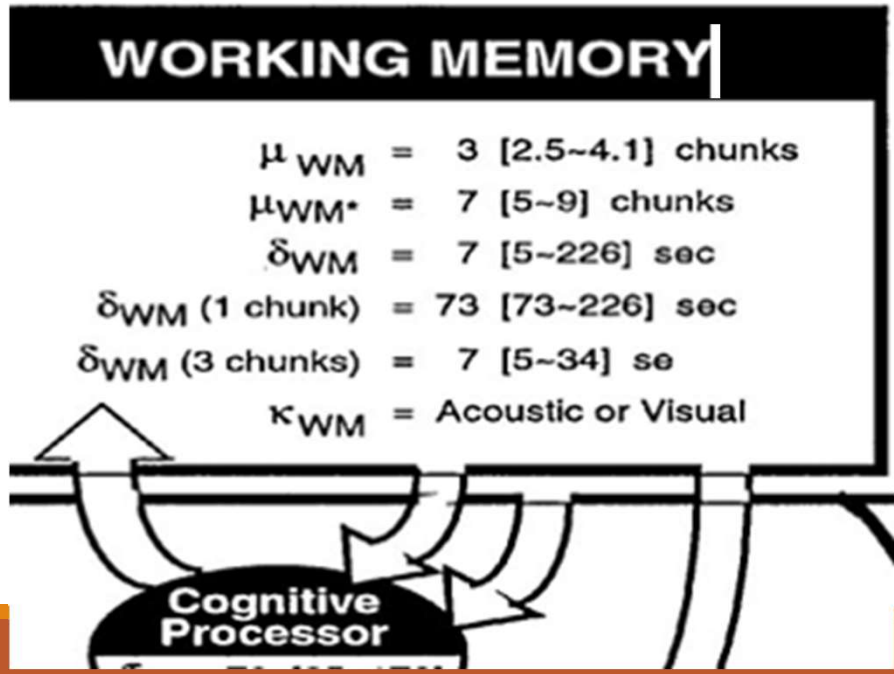
And then….

- Decision and Response selection
  - Once encoded, human must react
  - Can be automatic or controlled response
- Response execution
  - Sequence of behavior follows,
- Feedback
  - We monitor events and our actions
- Attention is usually required after STSS



Working or Short-term memory (STM)

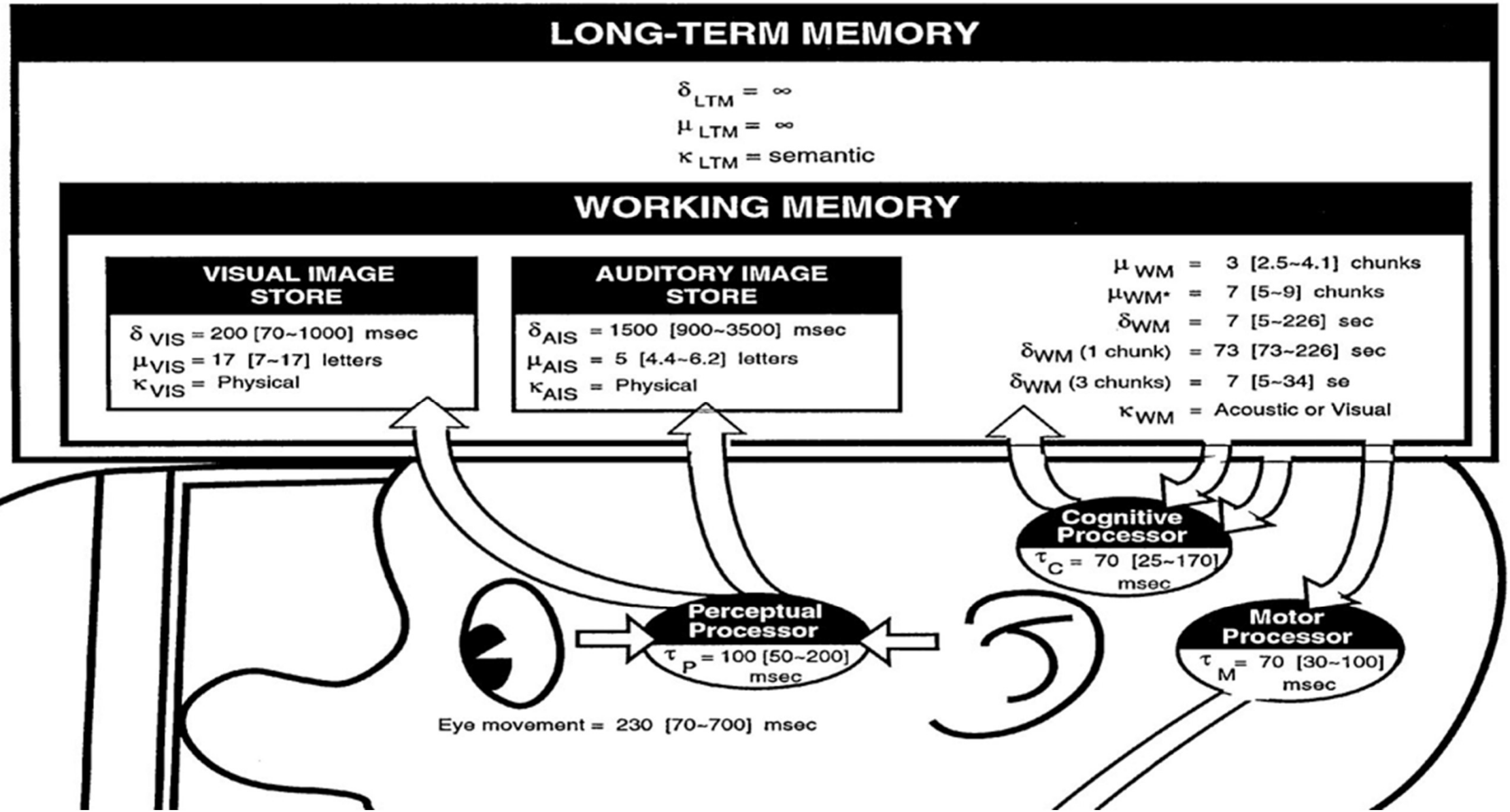
- Finite capacity buffer zone μ_{wm} = 7+/-2 chunks
- Limited duration δ_{wm} = 7 sec (decay)
- New information displaces old
- Rehearsal can maintain contents
- Chunking extends STM capacity



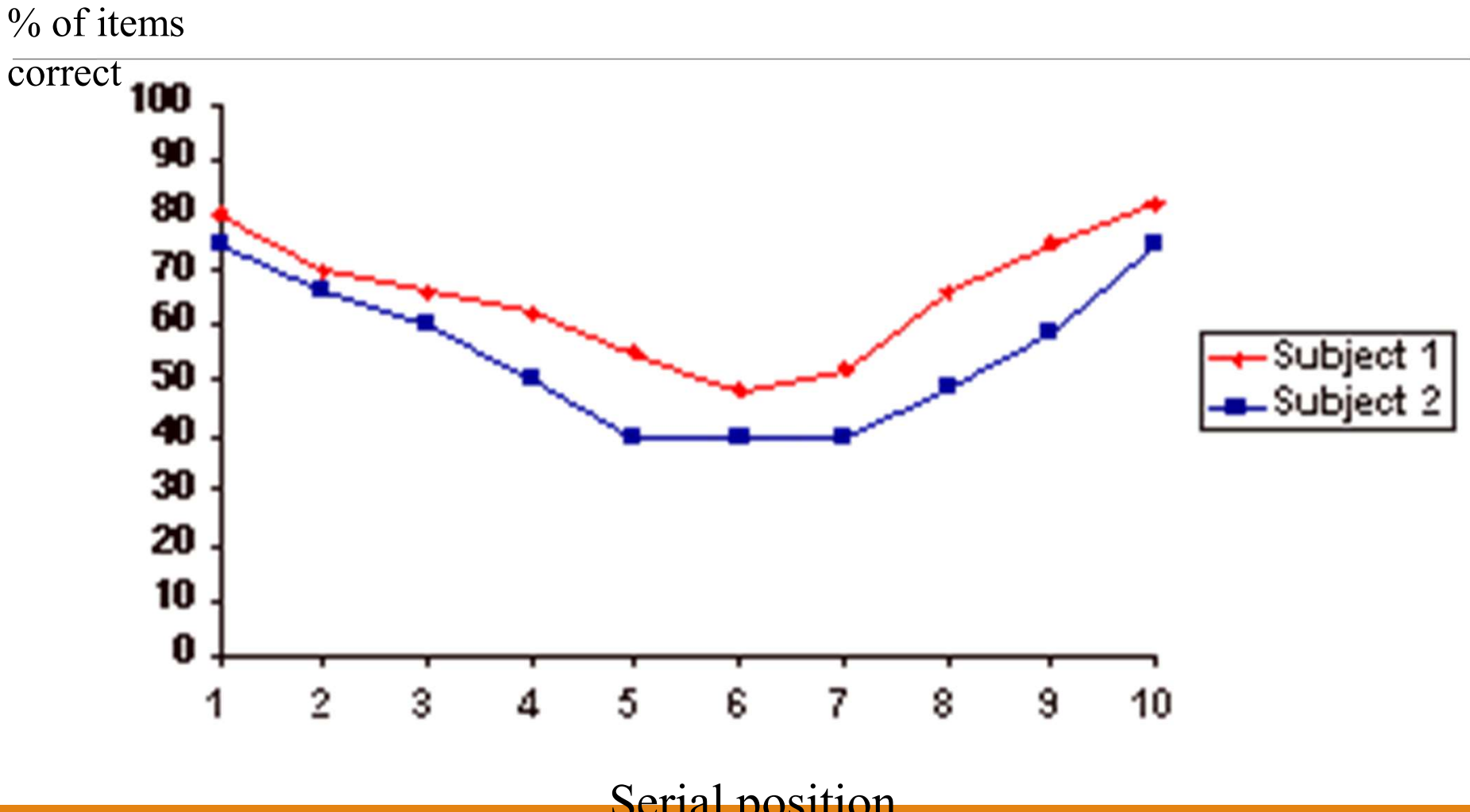
WM test - Put pencils down……

- I will read 10 numbers
- Remember them

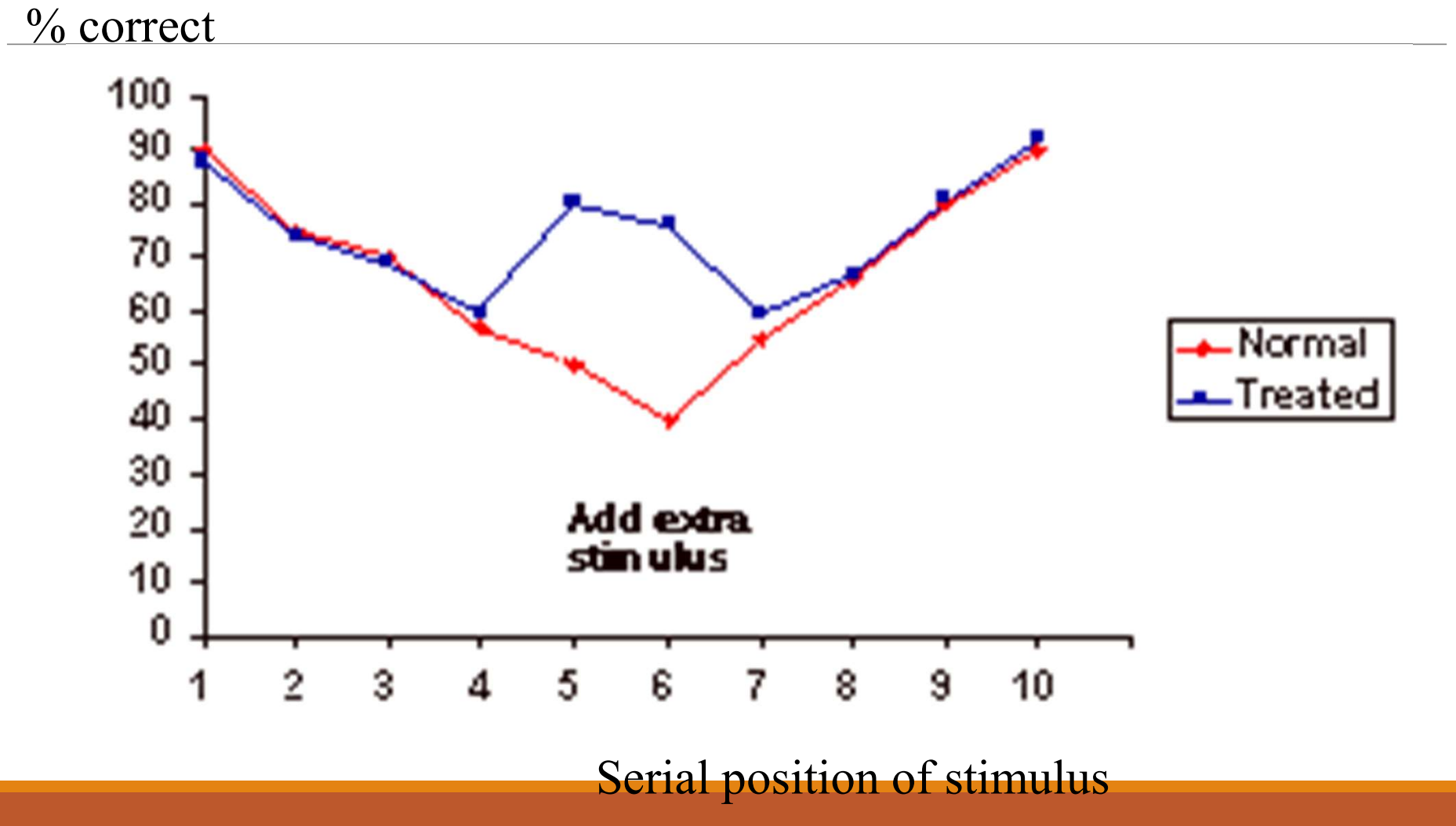
Write them down ……


LONG-TERM MEMORY
$\delta_{LTM} = \infty$
$\mu_{LTM} = \infty$
κ_{LTM} = semantic
WORKING MEMORY
VISUAL IMAGE STORE
δ_{VIS} = 200 [70~1000] msec
μ_{VIS} = 17 [7~17] letters
κ_{VIS} = Physical
AUDITORY IMAGE STORE
δ_{AIS} = 1500 [900~3500] msec
μ_{AIS} = 5 [4.4~6.2] letters
κ_{AIS} = Physical
μ_{WM} = 3 [2.5~4.1] chunks
μ_{WM*} = 7 [5~9] chunks
δ_{WM} = 7 [5~226] sec
δ_{WM} (1 chunk) = 73 [73~226] sec
δ_{WM} (3 chunks) = 7 [5~34] se
κ_{WM} = Acoustic or Visual
Cognitive Processor
τ_C = 70 [25~170] msec
Perceptual Processor
τ_P = 100 [50~200] msec
Motor Processor
τ_M = 70 [30~100] msec
Eye movement = 230 [70~700] msec

Primacy and Recency effects



Added cues improve recall

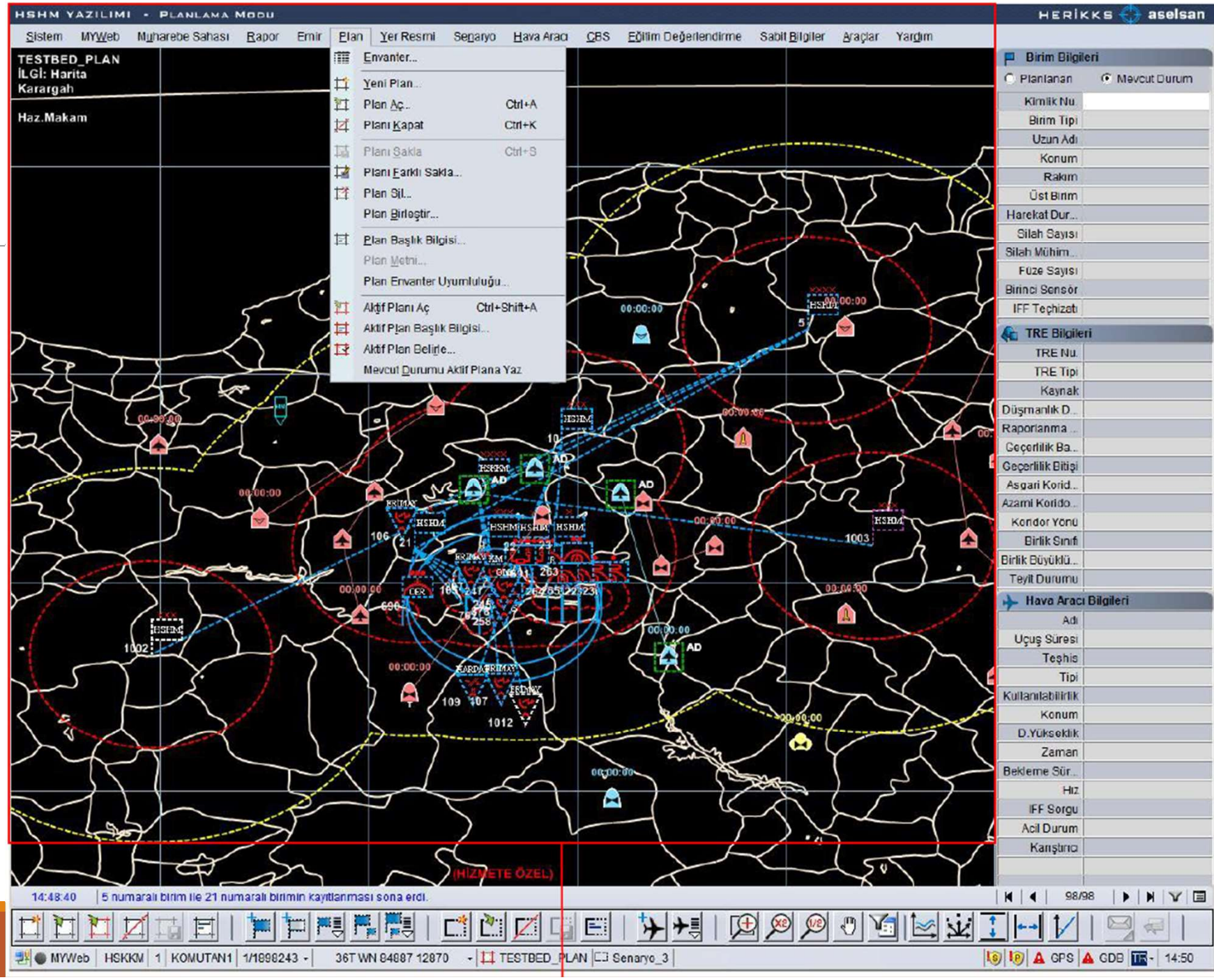


How about visual image store?

- I will show you 3 slides.
- In each slide count the number of objects and keep the time

In Real Life?

- Aselsan
- HERIKKS
- Air Defense Command Control Software



The value of chunking for recall

- SUNIBMMAC
- 2164839546

- Chunks must be meaningful for you

Remember them?

The value of chunking for recall

- Become:
  - SUN, IBM, MAC (3 chunks)
  - 2164839546 (1 chunk for me)

- Chunks must be meaningful for you

Meaningful chunking example

- Try to memorize the following:

Meaningful chunking example

- Try to memorize the following:

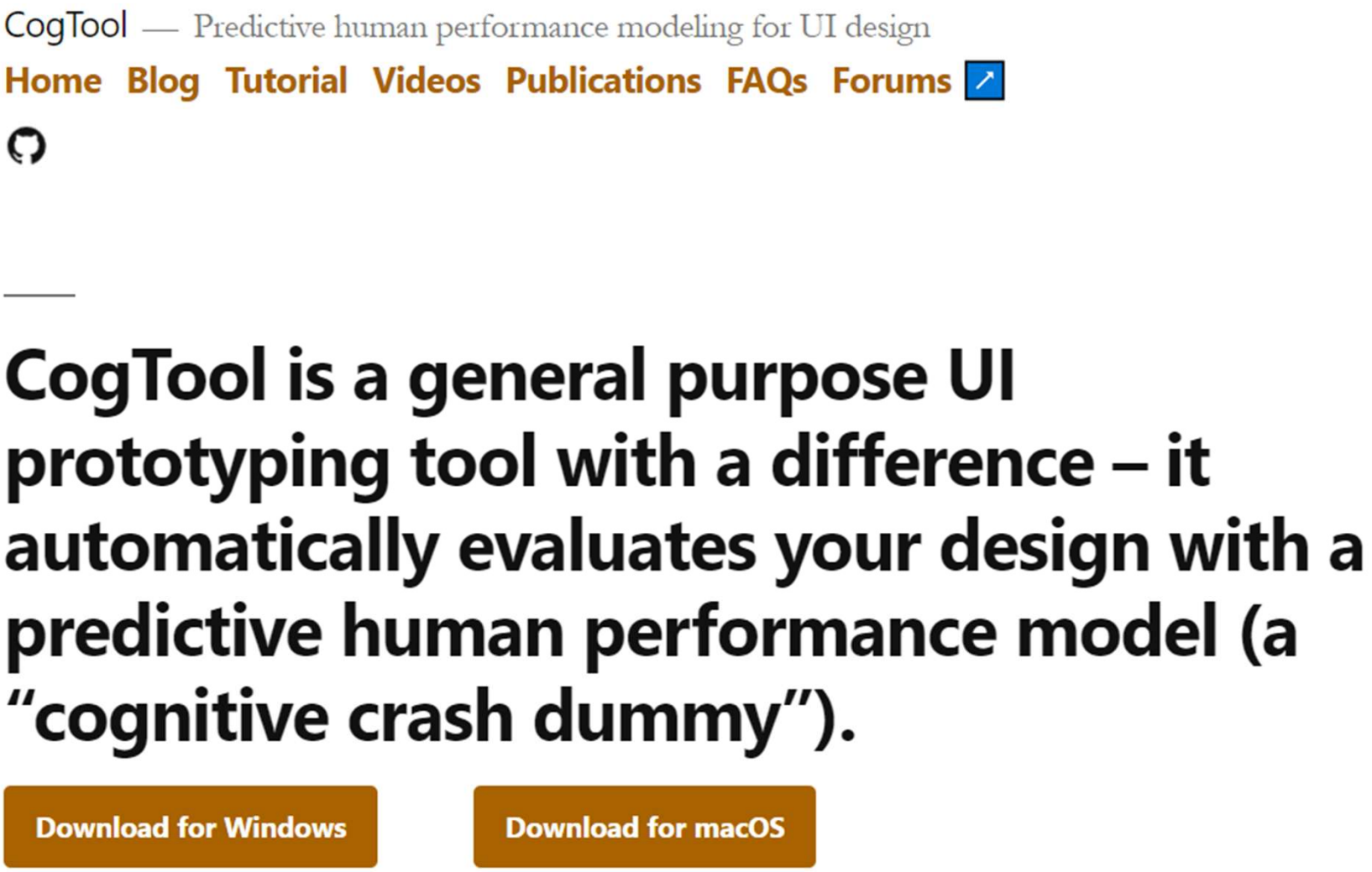
ocn, nph, dat, vfb, ith, yso, sib, mus, aat, t

Becomes more memorable as:

o cnn, phd, atv, fbi, thy, sos, ibm, usa, att

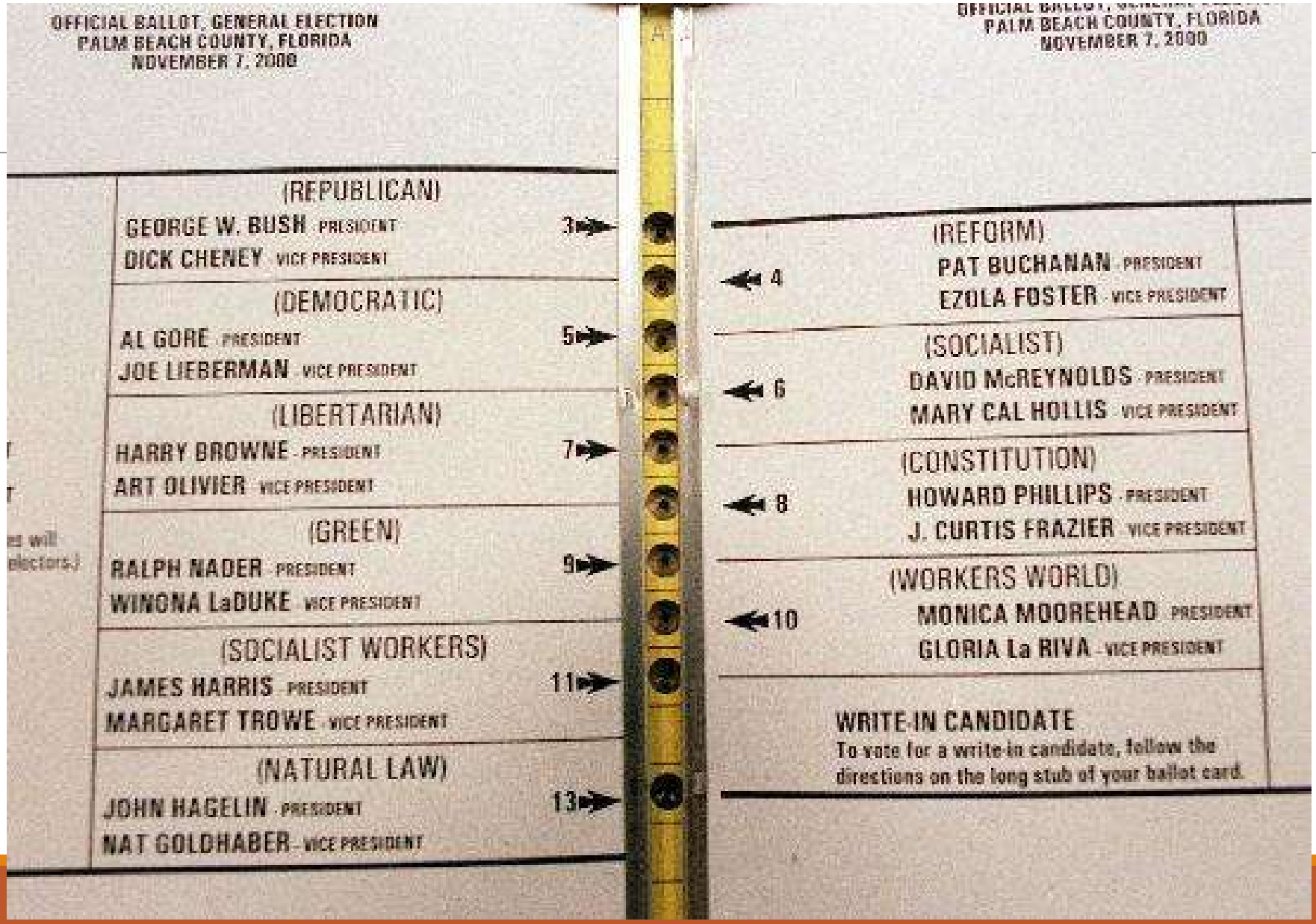
ocn, nph, dat, vfb, ith, yso, sib, mus, aat, t

https://www.cogtool.org/



Deadliest Design Problem

US elections - Palm Beach County



OFFICIAL BALLOT, GENERAL ELECTION
PALM BEACH COUNTY, FLORIDA
NOVEMBER 7, 2000

(REPUBLICAN)
GEORGE W. BUSH - PRESIDENT
DICK CHENEY - VICE PRESIDENT
3

(DEMOCRATIC)
AL GORE - PRESIDENT
JOE LIEBERMAN - VICE PRESIDENT
5

(LIBERTARIAN)
HARRY BROWNE - PRESIDENT
ART OLIVIER - VICE PRESIDENT
7

(GREEN)
RALPH NADER - PRESIDENT
WINONA LaDUKE - VICE PRESIDENT
9

(SOCIALIST WORKERS)
JAMES HARRIS - PRESIDENT
MARGARET TROWE - VICE PRESIDENT
11

(NATURAL LAW)
JOHN HAGELIN - PRESIDENT
NAT GOLDHABER - VICE PRESIDENT
13

OFFICIAL BALLOT, GENERAL ELECTION
PALM BEACH COUNTY, FLORIDA
NOVEMBER 7, 2000

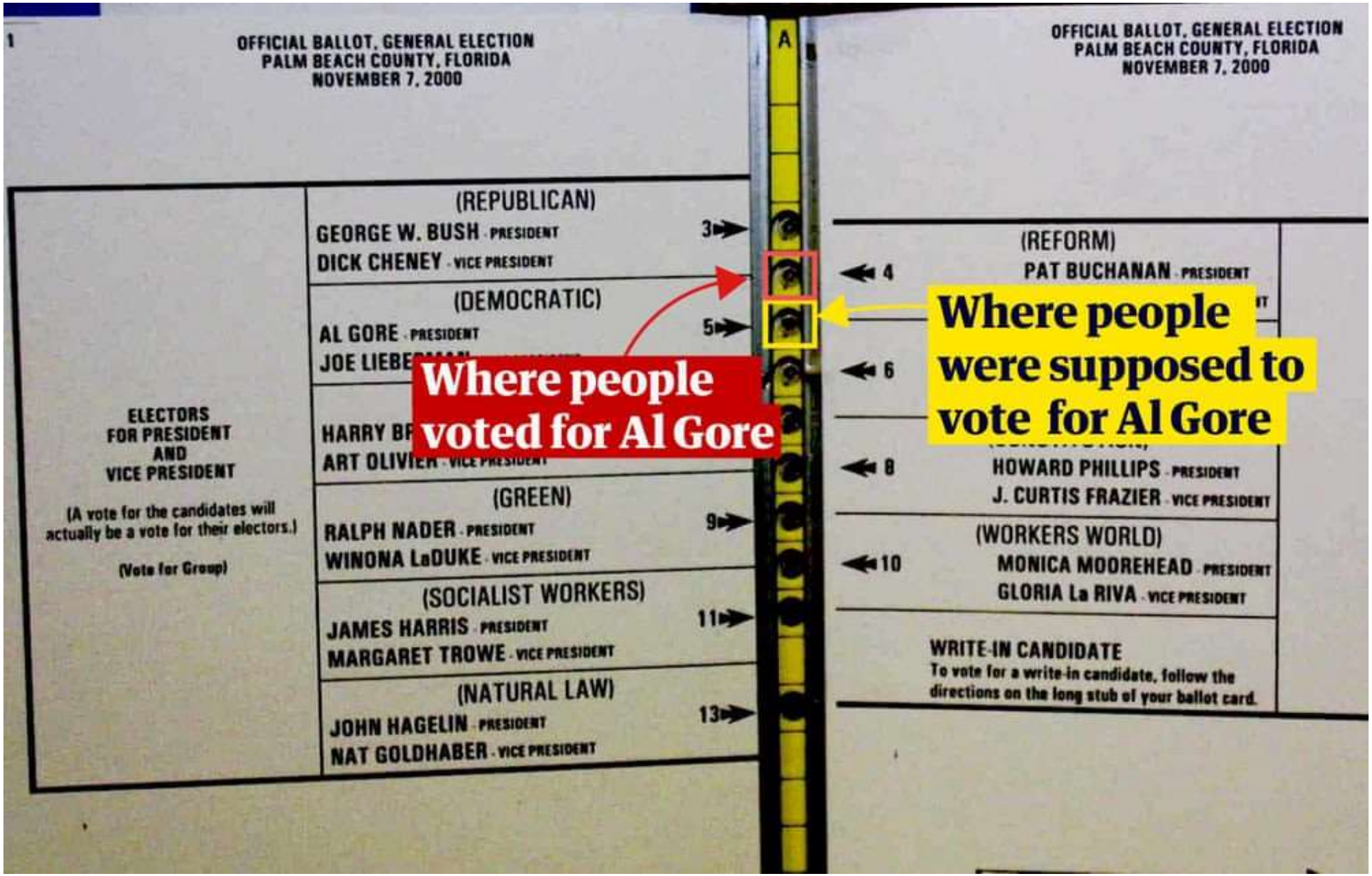
(REFORM)
PAT BUCHANAN - PRESIDENT
EZOLA FOSTER - VICE PRESIDENT
4

(SOCIALIST)
DAVID McREYNOLDS - PRESIDENT
MARY CAL HOLLIS - VICE PRESIDENT
6

(CONSTITUTION)
HOWARD PHILLIPS - PRESIDENT
J. CURTIS FRAZIER - VICE PRESIDENT
8

(WORKERS WORLD)
MONICA MOOREHEAD - PRESIDENT
GLORIA La RIVA - VICE PRESIDENT
10

WRITE-IN CANDIDATE
To vote for a write-in candidate, follow the directions on the long stub of your ballot card.


1
OFFICIAL BALLOT, GENERAL ELECTION
PALM BEACH COUNTY, FLORIDA
NOVEMBER 7, 2000
ELECTORS
FOR PRESIDENT
AND
VICE PRESIDENT
(A vote for the candidates will actually be a vote for their electors.)
(Vote for Group)
(REPUBLICAN)
GEORGE W. BUSH - PRESIDENT
DICK CHENEY - VICE PRESIDENT
3
(DEMOCRATIC)
AL GORE - PRESIDENT
5
Where people voted for Al Gore
(GREEN)
RALPH NADER - PRESIDENT
9
WINONA LaDUKE - VICE PRESIDENT
(SOCIALIST WORKERS)
JAMES HARRIS - PRESIDENT
11
MARGARET TROWE - VICE PRESIDENT
(NATURAL LAW)
JOHN HAGELIN - PRESIDENT
13
NAT GOLDHABER - VICE PRESIDENT
A
OFFICIAL BALLOT, GENERAL ELECTION
PALM BEACH COUNTY, FLORIDA
NOVEMBER 7, 2000
(REFORM)
4
PAT BUCHANAN - PRESIDENT
Where people were supposed to vote for Al Gore
6
8
HOWARD PHILLIPS - PRESIDENT
J. CURTIS FRAZIER - VICE PRESIDENT
(WORKERS WORLD)
10
MONICA MOOREHEAD - PRESIDENT
GLORIA La RIVA - VICE PRESIDENT
WRITE-IN CANDIDATE
To vote for a write-in candidate, follow the directions on the long stub of your ballot card.

Ballot problems

- Al Gore and Joe Lieberman are the second names on the ballot, but the third hole to punch
- Alignment of the text in each column
- The layout of double pages with punch holes in between was novel & unfamiliar. Ballots in previous elections had used only a single column with punch holes on the right.
- Confusing arrows and numbers
- Stress induced by the voting process
- “It was so hard to tell who and what you were voting for. I couldn't figure it out, and I have a doctorate,” voter Eileen Klasfeld said.
- http://danbricklin.com/log/ballotusability.htm
- http://www.humanfactors.com/library/election.asp